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(54) FIR FILTER AND METHOD FOR SETTING ITS COEFFICIENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an FIR(Finite Impulse Response) filter that can prevent equality of ripples from being deformed due to a weight approximation error and can keep a gain of a pass band to be nearly constant and to provide a method for setting its coefficient.

SOLUTION: This invention provides the method for setting a filter coefficient of the FIR filter that includes an initial setting step (F101) where setting of the FIR filter, setting of the band, setting of a coefficient of a pre-filter, and entry of a frequency point desirably to be passed and setting of an initial extremum point are conducted, a 1st step (F102) where an interpolation polynomial is generated, which interpolates the amplitude characteristic on the basis of the extremum point of the frequency versus amplitude characteristic and the frequency point desirably to be passed, a 2nd step (F103) where a new extreme point is decided on the basis of the amplitude characteristic obtained from the interpolation polynomial decided in the 1st step, a 3rd step (F104) where repeating the 1st and 2nd steps decides whether or not the position of the extremum value is approximated to be kept within a desired range, and a 4th step (F105) where the filter coefficient is obtained on the basis of the amplitude characteristic that is approximated in the 3rd step.

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CLAIMS

[Claim(s)]

[Claim 1] The FIR filter set up by an impulse response being expressed with finite time amount length, the impulse response concerned serving as a filter factor, and being the FIR filter with which transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and the above-mentioned filter factor's relating with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and performing approximation with weight to a desired property. [the pre-filter]

[Claim 2] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The FIR filter set up based on the amplitude characteristic of the equalizer obtained when the above-mentioned filter factor related with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass and performed approximation with weight to a desired property. [the pre-filter]

[Claim 3] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor by an impulse response being expressed with finite time amount length, and the impulse response concerned serving as a filter factor, and relating with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and performing approximation with weight to a desired property. [the pre-filter] [it is / pre-filter / the setting-out approach of the filter factor of an FIR filter that transfer function H (z) is related with transfer function / of a pre-filter / Z (z), and]

[Claim 4] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 3 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 5] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by relating with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and performing approximation with weight to a desired property. [the pre-filter]

[Claim 6] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 5 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 7] It is the setting-out approach of the filter factor of an FIR filter that an impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the extreme point of the amplitude characteristic of a frequency, and the frequency point which you want to pass, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The setting-out approach of the filter factor of an FIR filter which has the 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, and the 4th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated at the 3rd step of the above.

[Claim 8] The setting-out approach of the filter factor of an FIR filter according to claim 7 which has the initialization step which performs setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, input of the frequency point of arbitration [arbitration] to make it pass, and setting out of an initial extreme point at least before performing the 1st step of the above.

[Claim 9] The setting-out approach of the filter factor of the FIR filter according to claim 7 which search[for a rear spring supporter]-asks the whole approximation band for the extremal value of the approximation error with weight calculated from the extreme point used for interpolation at the 2nd step of the above, and the 3rd step, and is judged that optimal approximation was acquired when calculated extremal

value would be made into a new extreme point and the location of extremal value would not change.
[Claim 10] The setting-out approach of the filter factor of the FIR filter according to claim 7 which computes the above-mentioned filter factor by relating with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass at the 4th step of the above, and performing approximation with weight to a desired property. [the pre-filter]
[Claim 11] The setting-out approach of the filter factor of the FIR filter according to claim 7 which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by relating with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass at the 4th step of the above, and performing approximation with weight to a desired property. [the pre-filter]
[Claim 12] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 10 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 13] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 11 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 14] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned filter coefficient makes the above-mentioned number of taps adjustable and fixes a band [the pre-filter] The FIR filter set up by performing approximation with weight to a desired property.
[Claim 15] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned filter coefficient makes the above-mentioned number of taps

adjustable and fixes a band [the pre-filter] The FIR filter set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 16] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned number of taps is made adjustable and a band is fixed [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor by performing approximation with weight to a desired property.

[Claim 17] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 16 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 18] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned number of taps is made adjustable and a band is fixed [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 19] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 18 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 20] An impulse response is expressed with finite time amount length, the impulse response concerned serves as a filter factor, and the number of taps can be changed. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which is the setting-out approach of the filter factor of an FIR filter that the band is being fixed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The

2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the investigated magnitude of attenuation is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes the number of taps when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The setting-out approach of the filter factor of an FIR filter which has the 7th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated by the 3rd step of the above which was satisfied with the 5th step of the above of predetermined conditions.

[Claim 21] The setting-out approach of the filter factor of an FIR filter according to claim 20 which has at least the initialization step which specifies setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, and the magnitude of attenuation of an inhibition zone before performing the 1st step of the above.

[Claim 22] The setting-out approach of the filter factor of the FIR filter according to claim 20 which investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above, and increases the number of taps at the 6th step of the above.

[Claim 23] The setting-out approach of the filter factor of the FIR filter according to claim 20 which compute the above-mentioned filter factor by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when the above-mentioned number of taps be make adjustable and a band be fix to make it pass and may be satisfied with the 7th step of the above of the magnitude of attenuation of an inhibition zone . [the pre-filter]

[Claim 24] the setting out approach of the filter factor of the FIR filter according to claim 20 which compute the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that it might relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when the above-mentioned number of taps be make adjustable and a band be fix to make it pass and might be satisfied with the 7th step of the above of the magnitude of attenuation of an inhibition zone . [the pre-filter]

[Claim 25] The above-mentioned approximation with weight is the setting-out

approach of the filter factor of the FIR filter according to claim 23 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 26] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 24 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 27] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] Band setting out is an FIR filter set up by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when it can change. [the pre-filter]

[Claim 28] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The FIR filter set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 29] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor by performing approximation with weight to a desired property.

[Claim 30] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 28 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 31] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 32] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 31 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 33] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. The number of taps by immobilization The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the investigated magnitude of attenuation is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The setting-out approach of the filter factor of an FIR filter which has the 7th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated by the 3rd step of the above which was

satisfied with the 5th step of the above of predetermined conditions.
[Claim 34] The setting-out approach of the filter factor of an FIR filter according to claim 33 which has at least the initialization step which specifies setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, and the magnitude of attenuation of an inhibition zone before performing the 1st step of the above.
[Claim 35] The setting-out approach of the filter factor of an FIR filter according to claim 33 which investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above.
[Claim 36] it be the setting out approach of the filter factor of an FIR filter according to claim 33 that the above-mentioned number of taps compute the above-mentioned filter factor by performing approximation with weight to a desired property at the 7th step of the above so that band setting out may be relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone . [the pre-filter]
[Claim 37] it be the setting out approach of the filter factor of an FIR filter according to claim 33 that the above-mentioned number of taps compute the above-mentioned filter factor at the 7th step of the above with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that band setting out may be relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone . [the pre-filter]
[Claim 38] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 36 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 39] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 37 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 40] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] Band setting out is an FIR filter set up by performing

approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when it can change. [the pre-filter]

[Claim 41] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The FIR filter set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 42] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor by performing approximation with weight to a desired property.

[Claim 43] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 42 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 44] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the

filter factor of the FIR filter which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.
[Claim 45] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 44 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 46] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. The number of taps with adjustable The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the investigated magnitude of attenuation is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The 7th step which judges whether it can be satisfied with the 6th step of the above of the band modification back, and can be satisfied with the current number of taps of the magnitude of attenuation of an inhibition zone, The 8th step which changes the number of taps when it is judged that it is not satisfied with the 7th step of the above, The setting-out approach of the filter factor of an FIR filter which has the 9th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated by the 3rd step of the above which was satisfied with the 5th step of the above of predetermined conditions.
[Claim 47] The setting-out approach of the filter factor of an FIR filter according to claim 46 which has at least the initialization step which specifies setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, and the magnitude of attenuation of an inhibition zone before performing the 1st step of the above.
[Claim 48] The setting-out approach of the filter factor of the FIR filter according to claim 46 which investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above, and increases the number of taps at the 8th step

of the above.
[Claim 49] it be the setting out approach of the filter factor of an FIR filter according to claim 46 that the above-mentioned number of taps compute the above-mentioned filter factor by performing approximation with weight to a desired property at the 9th step of the above so that band setting out may be relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when it can change to make it pass and it may be satisfied with adjustable of the magnitude of attenuation of an inhibition zone . [the pre-filter]
[Claim 50] it be the setting out approach of the filter factor of an FIR filter according to claim 46 that the above-mentioned number of taps compute the above-mentioned filter factor at the 9th step of the above with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that band setting out may be relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when it can change to make it pass and it may be satisfied with adjustable of the magnitude of attenuation of an inhibition zone . [the pre-filter]
[Claim 51] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 49 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 52] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 50 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 53] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The FIR filter set up by performing approximation with weight to a desired property.
[Claim 54] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function

[of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The FIR filter set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 55] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor by performing approximation with weight to a desired property.

[Claim 56] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 55 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 57] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 58] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 57 performed to a

desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 59] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. The number of taps by immobilization The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the magnitude of attenuation investigated at the 4th step of the above is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The 7th step which investigates the magnitude of attenuation of the assignment frequency of a transient region which was satisfied with the 5th step of the above of predetermined conditions, The 8th step which judges whether the magnitude of attenuation of the transient region specified as the magnitude of attenuation of the assignment frequency of the transient region investigated at the 7th step of the above is measured, and the comparison result has satisfied predetermined conditions, The 9th step which changes setting out of a band when the comparison result of the 7th step of the above has not satisfied predetermined conditions, The setting-out approach of the filter factor of an FIR filter which has the 10th step which asks for the above-mentioned filter factor from the approximated amplitude characteristic which was satisfied with the 7th step of the above of predetermined conditions.

[Claim 60] The setting-out approach of the filter factor of an FIR filter according to claim 59 which has at least the initialization step which specifies the magnitude of attenuation in setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the assignment frequency of a transient region before performing the 1st step of the above.

[Claim 61] The setting-out approach of the filter factor of an FIR filter according to claim 59 which investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above.

[Claim 62] it be the setting out approach of the filter factor of an FIR filter according to claim 59 that the above-mentioned number of taps compute the above-mentioned filter factor by performing approximation with weight to a desired property at the 10th step of the above so that band setting out may be relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone , and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone . [the pre-filter]
[Claim 63] At the 10th step of the above, the above-mentioned number of taps by immobilization when band setting out can be changed So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter according to claim 59 which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.
[Claim 64] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 62 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 65] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 63 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 66] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The FIR filter set up by performing approximation with weight to a desired property.
[Claim 67] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the FIR filter with which it

has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The FIR filter set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 68] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor by performing approximation with weight to a desired property.

[Claim 69] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 68 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 70] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[Claim 71] The above-mentioned approximation with weight is the setting-out

approach of the filter factor of the FIR filter according to claim 70 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[Claim 72] An impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. The number of taps with adjustable The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the magnitude of attenuation investigated at the 4th step of the above is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The 7th step which judges whether it can be satisfied with the 6th step of the above of the band modification back, and can be satisfied with the current number of taps of the magnitude of attenuation of an inhibition zone, The 8th step which changes the number of taps when it is judged that it cannot be satisfied with the 7th step of the above, The 9th step which investigates the magnitude of attenuation of the assignment frequency of a transient region which was satisfied with the 5th step of the above of predetermined conditions, The 10th step which judges whether the magnitude of attenuation of the transient region specified as the magnitude of attenuation of the assignment frequency of the transient region investigated at the 9th step of the above is measured, and the comparison result has satisfied predetermined conditions, The 11th step which changes setting out of a band when the comparison result of the 10th step of the above has not satisfied predetermined conditions, The 12th step which judges whether the band modification back is passed at the 11th step of the above, and the assignment frequency of a transient region can be passed with the present number of taps, The 13th step which changes the number of taps when it judges that it cannot make it pass at the 12th step of the above, The setting-out approach of the filter factor of an FIR filter which has the 14th step which asks for the above-mentioned filter factor from the approximated amplitude characteristic which was satisfied with the 10th step of the above of predetermined conditions.

[Claim 73] The setting-out approach of the filter factor of an FIR filter according to

claim 72 which has at least the initialization step which specifies the magnitude of attenuation in setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the assignment frequency of a transient region before performing the 1st step of the above.
[Claim 74] The setting-out approach of the filter factor of the FIR filter according to claim 72 which investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above, and increases the number of taps at the 8th step of the above, and the 13th step.
[Claim 75] it be the setting out approach of the filter factor of an FIR filter according to claim 72 that the above-mentioned number of taps compute the above-mentioned filter factor by performing approximation with weight to a desired property at the 14th step of the above so that band setting out may be relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone , and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone . [the pre-filter]
[Claim 76] At the 14th step of the above, the above-mentioned number of taps by immobilization when band setting out can be changed So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The setting-out approach of the filter factor of the FIR filter according to claim 72 which computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.
[Claim 77] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 75 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.
[Claim 78] The above-mentioned approximation with weight is the setting-out approach of the filter factor of the FIR filter according to claim 76 performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the setting-out approach of an FIR filter required for digital signal processing, and its multiplier.
[0002]
[Description of the Prior Art] In digital signal processing of an image or voice, filtering is often used. A phase FIR (Finite Impulse Response; finite impulse response) filter is well used at least for a straight line from the description that the filter used for the filtering has a phase at least for a straight line with the number of taps of finite.
[0003] Drawing 1 is drawing in which at least a straight line shows the transversal mold circuitry of a phase FIR filter. The delay machine 2-1 to 2-n-1 of an individual (n-1) with which cascade connection only of this straight line is carried out to an input terminal TIN, and it constitutes a shift register as the phase FIR filter 1 is shown in drawing 1 , The signal and each delay machine 2-1 to 2-n-1 which were inputted into the input terminal TIN n multipliers 3-1 which carry out the multiplication of filter factor h (0) - the h (n-1) to an output signal, respectively - 3-n, The output signal of n multipliers 3-1 - 3-n is added, and it is an output terminal TOUT. It is constituted by the adder 4 to output.
[0004] As a design method with a as typical phase FIR filter as such a straight line For example, Parks and T.W.and The REMUZU exchange (Remez Exchange) algorithm with which McClellan, J.H. and others applied at least the straight line to the phase FIR filter is known (J.H.:). [Parks, T.W.and McClellan,] "Chebyshev Approximation for Nonrecursive Digital Filters with Linear Phase" and IEEE Trans. Circuit Theory and CT-19, 2, pp.189-194, 1972 and Rabiner, L.R., McClellan, J.H.and Parks, T.W.: "FIR Digital Filter Design Techniques Using Weighted Chebyshev Approximation", Proc.IEEE, Vol63, April, pp.595-610, and 1975 Reference.
[0005] A REMUZU exchange algorithm is an algorithm approximated so that it may become ripple forms [error / with weight / approximation] to the desired amplitude characteristic.
[0006] By the way, at least a straight line has resolution conversion of the image which used sampling rate conversion for application of filtering which used the phase FIR filter. In this resolution conversion, the multi-rate filter with which at least INTAPORETA (interpolator), DESHIMETA (infanticide machine), and a straight line make a phase FIR filter the component engineering is used (for example, refer to your family Hitoshi work, "multi-rate signal processing", Shokodo, and 1997).
[0007] Generally with a multi-rate filter, at least a straight line uses a phase FIR filter according to INTAPORETA, carrying out poliphase decomposition. INTAPORETA and DESHIMETA -- both -- the time of periodic -- an eternal system -- it is -- the time

-- an eternal system -- differing -- a property -- having . The distortion on the grid to which permanence is called chessboard distortion by resolution conversion of an image owing to at the time of periodic of the INTAPORETA will occur.
[0008] then, Harada and your family considered the conditions which avoid chessboard distortion from zero-point arrangement of a filter (Yasuhiro Harada and Hitoshi of your family: [ ] -- "the multi-rate filter which is not accompanied by chessboard distortion, and its zero-point arrangement" -- the **** techniques [pp / CAS and / 1-6] 96-78 and 1997-01).
[0009] For transfer function [of the multi-rate filter which is not accompanied by chessboard distortion] H (z), at least the straight line designed by a certain approach is a phase FIR filter (it is henceforth called an equalizer). In order to avoid chessboard distortion to transfer function K (z) afterwards, it is asked by carrying out the multiplication of the transfer function [of a zero point] Z (z).
[0010]
[Equation 1]
H(z) =Z (z) -K (z) -- (1)
[0011]
[Equation 2]
Z(z) =1+z-1+z-2+ ... +z- (U-1) -- (2)
[0012] Here, at least the straight line currently fixed beforehand will call a phase FIR filter a pre-filter like transfer function [of the zero point for avoiding chessboard distortion] Z (z). Moreover, at least a straight line may have to set direct-current gain at the time of a frequency w= 0 to 1 by the design specification of a phase FIR filter.
[0013] At least the straight line designed with the REMUZU exchange (Remez Exchange) algorithm which drawing 2 made the pre-filter the zero point (U= 3) for avoiding chessboard distortion, and took the frequency response of a pre-filter into consideration is drawing showing the example of a frequency response of a phase FIR filter. Moreover, at least the straight line designed with the REMUZU exchange (Remez Exchange) algorithm which drawing 3 sets direct-current gain of w= 0 to 1, specifies it as the zero point (gain 0 is taken by w=2pi/3) for avoiding chessboard distortion, and passes the frequency point of arbitration is drawing showing the example of a frequency response of a phase FIR filter.
[0014]
[Problem(s) to be Solved by the Invention] However, the REMUZU exchange (Remez Exchange) algorithm in consideration of the frequency response of a pre-filter has the following disadvantageous profits. That is, although Chebyshev approximation of the desired amplitude characteristic was able to be carried out in consideration of the frequency response of a pre-filter as shown in drawing 2 , in w= 0, gain is not 1 and has shifted. Therefore, with the REMUZU exchange (Remez Exchange) algorithm in consideration of the frequency response of a pre-filter, the amplitude characteristic

which passes the frequency point of the specified arbitration cannot be acquired.

[0015] Moreover, there are the following disadvantageous profits with the REMUZU exchange (Remez Exchange) algorithm which passes the frequency point of arbitration. that is, in the example here, as shown in drawing 3 , although it was realizable with the REMUZU exchange (Remez Exchange) algorithm which passes the frequency point of arbitration since what was necessary was just to have specified the zero point which avoids chessboard distortion, this is taking the frequency response of a pre-filter into consideration -- dividing -- coming out -- 7 -- it is -- ** Therefore, the REMUZU exchange (Remez Exchange) algorithm which passes the frequency point of arbitration can design a filter in consideration of the frequency response of a pre-filter, and is not boiled.

[0016] It is in offering the setting-out approach of the FIR filter which the object can acquire the amplitude characteristic which passes the frequency point of arbitration by making this invention in view of this situation , and the frequency response of a pre-filter can be take into consideration , and ripples , such as an approximation error with weight , do not collapse , and can hold the gain of a pass band to abbreviation constant value , and its multiplier .

[0017]

[Means for Solving the Problem] In order to attain the above-mentioned object, it is expressed with finite time amount length, and the impulse response concerned serves as a filter factor, and an impulse response relates with the frequency response of the frequency point which is the FIR filter with which transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and the above-mentioned filter factor wants to pass, and the above-mentioned pre-filter, and, as for this invention, is set up by performing approximation with weight to a desired property.

[0018] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned filter factor relates with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and is set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property. [the pre-filter]

[0019] Moreover, this invention computes the above-mentioned filter factor by an impulse response being expressed with finite time amount length, and the impulse response concerned serving as a filter factor, and relating with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and performing approximation with weight to a desired property. [the pre-filter] [it is / pre-filter / the setting-out approach of the filter factor of an FIR filter that transfer function H (z) is related with transfer function / of a pre-filter / Z (z), and]

[0020] Moreover, an impulse response is expressed with finite time amount length,

and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). It relates with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and the above-mentioned filter factor is computed with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property. [the pre-filter]

[0021] Moreover, in this invention, the above-mentioned approximation with weight is performed to a desired property using the REMUZU exchange (Remez Exchange) algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration.

[0022] Moreover, this invention is the setting-out approach of the filter factor of an FIR filter that an impulse response is expressed with finite time amount length, and the impulse response concerned serves as a filter factor. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the extreme point of the amplitude characteristic of a frequency, and the frequency point which you want to pass, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 1st step of the above and the 2nd step are repeated, and it has the 3rd step ended according to predetermined conditions, and the 4th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated at the 3rd step of the above.

[0023] In this invention, when it falls within the range which the maximum of an approximation error with desired amplitude value specified when it was judged whether it is the no by which the location of extremal value was approximated to request within the limits, for example as a terminating condition of the 3rd step, the case where the number of occurrence set up beforehand is reached can be adopted.

[0024] Moreover, in this invention, before performing the 1st step of the above, it has the initialization step which performs setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, input of the frequency point of arbitration [arbitration] to make it pass, and setting out of an initial extreme point at least.

[0025] Moreover, by this invention, at the 2nd step of the above, and the 3rd step, the whole approximation band is search[for a rear spring supporter]-asked for the extremal value of the approximation error with weight calculated from the extreme point used for interpolation, calculated extremal value is made into a new extreme point, and when the location of extremal value will not change, it is judged that optimal approximation was acquired.

[0026] Moreover, by this invention, at the 4th step of the above, it relates with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and the above-mentioned filter factor is computed by performing approximation with weight to a desired property. [the pre-filter]

[0027] Moreover, at this invention, at the 4th step of the above, it relates with the frequency response of the frequency point and the above-mentioned pre-filter to make it pass, and the above-mentioned filter factor is computed with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property. [the pre-filter]

[0028] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned filter coefficient makes the above-mentioned number of taps adjustable and fixes a band [the pre-filter] It is set up by performing approximation with weight to a desired property.

[0029] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned filter coefficient makes the above-mentioned number of taps adjustable and fixes a band [the pre-filter] It is set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[0030] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). So that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned number of taps is made adjustable and a band is fixed [the pre-filter] The above-mentioned filter factor is computed by performing approximation with weight to a desired property.

[0031] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). So that it may relate with

the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied, when the above-mentioned number of taps is made adjustable and a band is fixed [the pre-filter] The above-mentioned filter factor is computed with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.
[0032] Moreover, an impulse response is expressed with finite time amount length, the impulse response concerned serves as a filter factor, and this invention can change the number of taps. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which is the setting-out approach of the filter factor of an FIR filter that the band is being fixed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the investigated magnitude of attenuation is measured, and the comparison result has satisfied predetermined conditions, It has the 7th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated by the 6th step which changes the number of taps when the comparison result of the 5th step of the above has not satisfied predetermined conditions, and the 3rd step of the above which was satisfied with the 5th step of the above of predetermined conditions.
[0033] Moreover, in this invention, before performing the 1st step of the above, it has the initialization step which specifies setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, and the magnitude of attenuation of an inhibition zone at least.
[0034] Moreover, this invention investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above, and the number of taps is increased at the 6th step of the above.
[0035] Moreover, in this invention, the above-mentioned filter factor is computed by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and may be satisfied with the 7th step of the above of the magnitude of attenuation of an inhibition zone, when the above-mentioned number of taps is made adjustable and a band is fixed. [the pre-filter]
[0036] Moreover, in this invention, the above-mentioned filter factor is computed with

the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and may be satisfied with the 7th step of the above of the magnitude of attenuation of an inhibition zone, when the above-mentioned number of taps is made adjustable and a band is fixed. [the pre-filter]

[0037] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] When it can change, band setting out is related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass, and it is set up by performing approximation with weight to a desired property so that the magnitude of attenuation of an inhibition zone may be satisfied. [the pre-filter]

[0038] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] It is set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[0039] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization When it can change, band setting out computes the above-mentioned filter factor by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied. [the pre-filter]

[0040] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of

arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The above-mentioned filter factor is computed with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[0041] Moreover, an impulse response is expressed with finite time amount length, as for this invention, the impulse response concerned serves as a filter factor, and the number of taps is immobilization. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the investigated magnitude of attenuation is measured, and the comparison result has satisfied predetermined conditions, It has the 7th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated by the 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, and the 3rd step of the above which was satisfied with the 5th step of the above of predetermined conditions.

[0042] Moreover, in this invention, before performing the 1st step of the above, it has the initialization step which specifies setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, and the magnitude of attenuation of an inhibition zone at least.

[0043] Moreover, this invention investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above.

[0044] Moreover, by this invention, at the 7th step of the above, the above-mentioned number of taps computes the above-mentioned filter factor by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when band setting out can be changed to make it pass and may be satisfied with immobilization of the magnitude

of attenuation of an inhibition zone. [the pre-filter]
[0045] Moreover, at this invention, at the 7th step of the above, the above-mentioned number of taps computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone. [the pre-filter]
[0046] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] When it can change, band setting out is related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass, and it is set up by performing approximation with weight to a desired property so that the magnitude of attenuation of an inhibition zone may be satisfied. [the pre-filter]
[0047] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] It is set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.
[0048] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable When it can change, band setting out computes the above-mentioned filter factor by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied. [the pre-filter]
[0049] Moreover, an impulse response is expressed with finite time amount length,

and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable When band setting out can be changed, so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The above-mentioned filter factor is computed with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[0050] Moreover, an impulse response is expressed with finite time amount length, as for this invention, the impulse response concerned serves as a filter factor, and the number of taps is adjustable. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the investigated magnitude of attenuation is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The 7th step which judges whether it can be satisfied with the 6th step of the above of the band modification back, and can be satisfied with the current number of taps of the magnitude of attenuation of an inhibition zone, When it is judged that it is not satisfied with the 7th step of the above, it has the 9th step which asks for the above-mentioned filter factor from the amplitude characteristic approximated by the 8th step which changes the number of taps, and the 3rd step of the above which was satisfied with the 5th step of the above of predetermined conditions.

[0051] Moreover, in this invention, before performing the 1st step of the above, it has the initialization step which specifies setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, and the magnitude of attenuation of an inhibition zone at least.

[0052] Moreover, this invention investigates the minimum magnitude of attenuation in

an inhibition zone at the 4th step of the above, and the number of taps is increased at the 8th step of the above.

[0053] Moreover, by this invention, at the 9th step of the above, the above-mentioned number of taps computes the above-mentioned filter factor by performing approximation with weight to a desired property so that it may relate with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when band setting out can be changed to make it pass and may be satisfied with adjustable of the magnitude of attenuation of an inhibition zone. [the pre-filter]

[0054] Moreover, at this invention, at the 9th step of the above, the above-mentioned number of taps computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone when it can change to make it pass and it may be satisfied with adjustable of the magnitude of attenuation of an inhibition zone. [the pre-filter]

[0055] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] It is set up by performing approximation with weight to a desired property.

[0056] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] It is set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[0057] Moreover, an impulse response is expressed with finite time amount length,

and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps by immobilization So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The above-mentioned filter factor is computed by performing approximation with weight to a desired property.

[0058] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps by immobilization So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The above-mentioned filter factor is computed with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[0059] Moreover, an impulse response is expressed with finite time amount length, as for this invention, the impulse response concerned serves as a filter factor, and the number of taps is immobilization. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the magnitude of attenuation investigated at the 4th step of the above is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The 7th step which investigates the

magnitude of attenuation of the assignment frequency of a transient region which was satisfied with the 5th step of the above of predetermined conditions, The 8th step which judges whether the magnitude of attenuation of the transient region specified as the magnitude of attenuation of the assignment frequency of the transient region investigated at the 7th step of the above is measured, and the comparison result has satisfied predetermined conditions, It has the 9th step which changes setting out of a band when the comparison result of the 7th step of the above has not satisfied predetermined conditions, and the 10th step which asks for the approximated amplitude characteristic which was satisfied with the 7th step of the above of predetermined conditions to the above-mentioned filter factor.

[0060] Moreover, in this invention, before performing the 1st step of the above, it has the initialization step which specifies the magnitude of attenuation in setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the assignment frequency of a transient region at least.

[0061] Moreover, this invention investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above.

[0062] Moreover, by this invention, at the 10th step of the above, the above-mentioned number of taps computes the above-mentioned filter factor by performing approximation with weight to a desired property so that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone. [the pre-filter]

[0063] Moreover, at this invention, the above-mentioned number of taps computes the above-mentioned filter factor at the 10th step of the above with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and passes the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone. [the pre-filter]

[0064] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-

mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] It is set up by performing approximation with weight to a desired property.

[0065] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the FIR filter with which it has the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable [the above-mentioned filter factor] So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] It is set up based on the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property.

[0066] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z). The above-mentioned number of taps with adjustable So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The above-mentioned filter factor is computed by performing approximation with weight to a desired property.

[0067] Moreover, an impulse response is expressed with finite time amount length, and, as for this invention, the impulse response concerned serves as a filter factor. It is the setting-out approach of the filter factor of an FIR filter that have the tap of arbitration and transfer function H (z) is related with transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z). The above-mentioned number of taps with adjustable So that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and the magnitude of attenuation of an inhibition zone may be satisfied [the pre-filter] The above-mentioned filter factor is computed with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a

desired property.

[0068] Moreover, an impulse response is expressed with finite time amount length, as for this invention, the impulse response concerned serves as a filter factor, and the number of taps is adjustable. The 1st step which generates the interpolation polynomial which interpolates the amplitude characteristic from the frequency point which band setting out is the setting-out approach of the filter factor of the FIR filter which can be changed, and you want to pass with the extreme point of the amplitude characteristic of a frequency, The 2nd step which determines a new extreme point from the amplitude characteristic searched for from the interpolation polynomial obtained at the 1st step of the above, The 3rd step which repeats the 1st step of the above, and the 2nd step, and is ended according to predetermined conditions, The 4th step which investigates the magnitude of attenuation of an inhibition zone from the amplitude characteristic approximated at the 3rd step of the above, The 5th step which judges whether the magnitude of attenuation of the inhibition zone specified as the magnitude of attenuation investigated at the 4th step of the above is measured, and the comparison result has satisfied predetermined conditions, The 6th step which changes setting out of a band when the comparison result of the 5th step of the above has not satisfied predetermined conditions, The 7th step which judges whether it can be satisfied with the 6th step of the above of the band modification back, and can be satisfied with the current number of taps of the magnitude of attenuation of an inhibition zone, The 8th step which changes the number of taps when it is judged that it cannot be satisfied with the 7th step of the above, The 9th step which investigates the magnitude of attenuation of the assignment frequency of a transient region which was satisfied with the 5th step of the above of predetermined conditions, The 10th step which judges whether the magnitude of attenuation of the transient region specified as the magnitude of attenuation of the assignment frequency of the transient region investigated at the 9th step of the above is measured, and the comparison result has satisfied predetermined conditions, The 11th step which changes setting out of a band when the comparison result of the 10th step of the above has not satisfied predetermined conditions, The 12th step which judges whether the band modification back is passed at the 11th step of the above, and the assignment frequency of a transient region can be passed with the present number of taps, It has the 13th step which changes the number of taps when it judges that it cannot make it pass at the 12th step of the above, and the 14th step which asks for the approximated amplitude characteristic which was satisfied with the 10th step of the above of predetermined conditions to the above-mentioned filter factor.

[0069] Moreover, in this invention, before performing the 1st step of the above, it has the initialization step which specifies the magnitude of attenuation in setting out of an FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone,

and the assignment frequency of a transient region at least.
[0070] Moreover, this invention investigates the minimum magnitude of attenuation in an inhibition zone at the 4th step of the above, and the number of taps is increased at the 8th step of the above, and the 13th step.
[0071] Moreover, by this invention, at the 14th step of the above, the above-mentioned number of taps computes the above-mentioned filter factor by performing approximation with weight to a desired property so that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone. [the pre-filter]
[0072] Moreover, at this invention, at the 14th step of the above, the above-mentioned number of taps computes the above-mentioned filter factor with the amplitude characteristic of the equalizer obtained by performing approximation with weight to a desired property so that band setting out may be related with the frequency response of the frequency point and the above-mentioned pre-filter which satisfy the magnitude of attenuation of an inhibition zone, and pass the magnitude of attenuation of the assignment frequency of a transient region when it can change to make it pass and it may be satisfied with immobilization of the magnitude of attenuation of an inhibition zone. [the pre-filter]
[0073] According to this invention, setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, input of the frequency point of arbitration [arbitration] to make it passing, and setting out of an initial extreme point are performed at least for a straight line by initial setting, for example. Next, the interpolation polynomial which interpolates the amplitude characteristic from a current extreme point and the frequency point which you want to pass is generated. Next, a new extreme point is determined from the amplitude characteristic searched for from the generated interpolation polynomial. It is judged whether these were repeated, for example, the location of extremal value was approximated to request within the limits. And a filter factor is called for from the approximated amplitude characteristic. Thus, the FIR filter which a multiplier is set up and is becomes ripples [error / with weight / approximation], and the gain of a pass band is maintained at constant value. Moreover, the specified frequency point can be passed.
[0074]
[Embodiment of the Invention] Hereafter, it relates with a drawing and the gestalt of operation of this invention is explained.
[0075] It is possible to take transversal mold circuitry as shown in drawing 1 as equivalent [a phase FIR filter] as the straight line concerning this invention. However, filter factor h carries out Chebyshev approximation of the desired amplitude characteristic, after extending the REMUZU exchange (Remez Exchange) algorithm,

and being able to specify the frequency point which you want to pass and taking the frequency response of a pre-filter into consideration so that it may explain in full detail below, and it is called for from the approximated amplitude characteristic.

[0076] Hereafter, about the concrete approach of multiplier setting out of at least the straight line concerning this invention of a phase FIR filter, it relates with a drawing and order is explained later on.

[0077] Like a formula (3), at least the straight line of N tap is the filter with which transfer function [of a phase FIR filter] H (z) consists of the product of transfer function [of a pre-filter] Z (z), and transfer function [of an equalizer] K (z).

[0078]

[Equation 3]

H(z) =Z (z) -K (z) -- (3)

[0079] Here, at least the straight line of U tap and N-(U-1) tap of a pre-filter and an equalizer shall be a phase FIR filter, respectively, and the transfer function of a pre-filter shall be given beforehand. Moreover, the frequency point of the arbitration of Np individual is passed in a frequency domain. Therefore, the filter design of here transfer function H (z) is determining transfer function [of the equalizer of N-(U-1) tap] K (z), as the frequency point of the specified arbitration is passed and the amplitude characteristic H (ejw) is brought close to the desired amplitude characteristic D (ejw).

[0080] The number of taps assigned to the equalizer of transfer function K (z) is set with L=N- (U-1). Since transfer function [of a phase FIR filter] K (z) has a phase at least for a straight line as shown in drawing 4 , in the case of four, at least a straight line is classified. It is classified into four case of 4 when symmetrical with the even number tap specifically shown in 3 and drawing 4 (D) when symmetrical with the odd number tap shown in 2 and drawing 4 (C) when symmetrical with the even number tap shown in 1 and drawing 4 (B) when symmetrical with the odd number tap shown in drawing 4 (A), and **, and **, and **, and **.

[0081] and the amplitude characteristic function K (ejw) -- a case -- 1 -- leaving as it is -- a case -- 2-4 -- as follows -- rewriting .

[0082]

[Equation 4]

場合1: $\sum_{n=0}^{(L-1)/2} a(n)\cos(n\omega)$ (4-1)

場合2: $\sum_{n=1}^{L/2} b(n)\cos\left\{\left(n-\frac{1}{2}\right)\omega\right\}$
$=\cos\left(\frac{\omega}{2}\right)\sum_{n=0}^{L/2-1} \tilde{b}(n)\cos(n\omega)$ (4-2)

場合3: $\sum_{n=1}^{(L-1)/2} c(n)\sin(n\omega)$
$=\sin(\omega)\sum_{n=0}^{(L-3)/2} \tilde{c}(n)\cos(n\omega)$ (4-3)

場合4: $\sum_{n=1}^{L/2} d(n)\sin\left\{\left(n-\frac{1}{2}\right)\omega\right\}$
$=\sin\left(\frac{\omega}{2}\right)\sum_{n=0}^{L/2-1} \tilde{d}(n)\cos(n\omega)$ (4-4)

[0083] That is, the amplitude characteristic function K (ejw) is expressed with a product with the cosine series P (ejw) containing Function Q (ejw) and the design parameter of the fixed parameter shown in drawing 5 . Henceforth, the upper limit of each type (4-1) - (formula 4-4) the sum will be expressed as R-1+2xNp. That is, R is calculated like drawing 5 . Moreover, a (n); ~b (n);~c (n); ~d (n) It is named p (n) generically.
[0084] When considering as the desired amplitude characteristic D (ejw) and setting weight to each frequency to W (ejw), the approximation error with weight is defined as follows.
[0085]
[Equation 5]
$$E(e^{j\omega})= W(e^{j\omega})\left\{D(e^{j\omega})-H(e^{j\omega})\right\} \qquad (5)$$

[0086]
[Equation 6]
$$\begin{aligned} H(e^{j\omega})&= K(e^{j\omega})\cdot Z(e^{j\omega}) \\ &= Q(e^{j\omega})\cdot P(e^{j\omega})\cdot Z(e^{j\omega}) \qquad (6)\end{aligned}$$

[0087] It is as follows when a formula (6) is substituted for a formula (5).
[0088]
[Equation 7]
$$E(e^{j\omega}) = \hat{W}(e^{j\omega})\left\{\hat{D}(e^{j\omega})-P(e^{j\omega})\right\} \qquad (7)$$

[0089] However, ^W (ejw) and ^D (ejw) presuppose that it is as follows.
[0090]
[Equation 8]

$$\hat{W}(e^{j\omega}) = W(e^{j\omega}) \cdot Q(e^{j\omega}) \cdot Z(e^{j\omega}) \qquad (8)$$

[0091]
[Equation 9]

$$\hat{D}(e^{j\omega}) = \frac{D(e^{j\omega})}{Q(e^{j\omega}) \cdot Z(e^{j\omega})} \qquad (9)$$

[0092] a formula (7) -- a case -- 1- case -- 4 -- at least the straight line in four expresses the approximation error with weight of a phase FIR filter. The Chebyshev approximation problem with weight is a (n) of formula (4-1) - (4-4) which makes min maximum of |E(ejw) | in the area within an assigned frequency band in a formula (5).; ~b(n);~c(n);~d (n) It is determining.
[0093] It relates with an example hereafter and explains. Here, as shown in the following and drawing 6 , the amplitude characteristic D (ejw) is defined.
[0094]
[Equation 10]

$$\begin{aligned} D(e^{j\omega}) &= 1 \quad (\text{誤差}\pm\delta_1\text{以内}, 0 < \omega < \omega_p) \\ D(e^{j\omega}) &= 0 \quad (\text{誤差}\pm\delta_2\text{以内}, \omega_s < \omega < \pi) \end{aligned} \qquad (10)$$

[0095] However, when R is given, it is delta 1 and delta 2. The ratio can be specified although a value cannot be specified as arbitration. W (ejw) is W2 at constant value W1 and an inhibition zone in a pass band. It carries out and is W1. delta1 =W2 delta 2 It chooses so that it may be materialized. For example, W1 =1, W2 =delta1 / delta 2 It chooses. The following alternation theorem is realized at this time.
[0096] a theorem (R-1) -- a necessary and sufficient condition for the following cosine series P (ejw) to be the Chebyshev approximation with the best weight to an objective characteristic in the section (0 pi) of w -- (1) E (ejw) should take a time and extremal value at least (R+1) in the section (0 pi). the frequency which takes the extremal value at that time -- w0 -- < -- w1 -- < -- w2 -- < .. < -- wR-1 <wR ** -- it carries out. (2) It is that the absolute value of all extremal value is [whose signs of adjacent extremal value differ] equal. That is, the following conditions are satisfied.
[0097]
[Equation 11]

$$\begin{aligned} E(e^{j\omega_i}) \cdot E(e^{j\omega_{i+1}}) &< 0 \quad (i=0, 1, \ldots, R-1) \\ |E(e^{j\omega_i})| &= |E(e^{j\omega_{i+1}})| \quad (i=0, 1, \ldots, R-1) \end{aligned} \qquad (11)$$

[0098] Therefore, |E(ejwi) | is equal to the maximum of |E(ejw) | within the section.
[0099] The REMUZU exchange algorithm (Remez Exchange Algorithm) based on an alternation theorem is in the technique of obtaining best Chebyshev approximation (refer to Rabiner, L.R., McClellan, J.H.andParks, T.W.: "FIR Digital Filter Design Techniques Using Weighted Chebyshev Approximation", Proc.IEEE, Vol 63, April, pp.595-610, and 1975). Chebyshev approximation of the desired amplitude

characteristic is carried out in a frequency domain, and, as for a REMUZU exchange algorithm, at least a straight line asks for the multiplier of a phase FIR filter from the approximated amplitude characteristic.

[0100] <u>Drawing 7</u> is the flow chart of the REMUZU exchange algorithm which passed the frequency point of the arbitration concerning this invention, and took the frequency response of a pre-filter into consideration. The REMUZU exchange algorithm in consideration of the frequency response of a concrete pre-filter is as follows.

[0101] As shown in step0 <u>drawing 7</u> , initial setting is performed first (F101). In this initial setting, at least a straight line performs setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, input of the frequency point of arbitration [arbitration] to make it pass, and setting out of an initial extreme point. The item set up concretely is as follows.

- The number of taps, as symmetrical [a phase FIR filter] with ** as - straight line or a ** symmetrical, - The number of bands, the frequency of the ends of - each band, the amplitude value of a request of - each band, - The multiplier of weighting to each band, and - pre-filter, the frequency of a point which you want to pass, and frequency [which serves as extremal value in amplitude value (wR+i, D (ejwR+1), i= 1, .., Np) and - approximation band] w (0) = wk (0) (k= 0, .., R)

However, right superscript (i) The count of a repeat is expressed.

[0102] step1, next the Lagrange interpolation polynomial which interpolates the amplitude characteristic from a current extreme point are generated (F102). The necessary and sufficient condition from which the performance index of Chebyshev approximation shown by the above-mentioned formula (5) becomes min is shown by the alternation theorem. then, a basis [theorem / alternation] -- carrying out -- approximation error [from the amplitude characteristic of a request at each frequency point] with weight delta (i) It is equal, and it asks for parameter [of a degree type] p (n) so that a sign may carry out alternation.

[0103]

[Equation 12]

$$P(e^{j\omega}) = \sum_{n=0}^{R-1} p(n) \cos(n\omega) \qquad (12)$$

[0104] Namely, frequency point w (i) = wk (i) (k= 0, .., R) The approximation error with weight of the formula (7) which can be set satisfies a degree type.

[0105]

[Equation 13]

$$\hat{W}(e^{j\omega_k^{(i)}})\left\{\hat{D}(e^{j\omega_k^{(i)}}) - P(e^{j\omega_k^{(i)}})\right\} = (-1)^k \delta^{(i)} \quad (k=0, 1, \ldots, R) \qquad (13)$$

[0106] It is a right superscript (i) because of the following and simplification. It omits. It is as follows when a formula (13) is transformed.

[0107]

[Equation 14]

$$P(e^{j\omega_k}) + \frac{(-1)^k \delta}{\hat{W}(e^{j\omega_k})} = \hat{D}(e^{j\omega_k})$$

$$\sum_{n=0}^{R-1} p(n)\cos(n\omega_k) + \frac{(-1)^k \delta}{\hat{W}(e^{j\omega_k})} = \hat{D}(e^{j\omega_k}) \quad (k=0, 1, \ldots, R) \qquad (14)$$

[0108] And the equality of a point which a formula (14) wants to pass as constraint in a frequency domain is added.

[0109]

[Equation 15]

$$P(e^{j\omega_k}) = \hat{D}(e^{j\omega_k})$$

$$\sum_{n=0}^{R-1} p(n)\cos(n\omega_k) = \hat{D}(e^{j\omega_k}), \quad (k = R+1, \ldots, R+N_p) \qquad (15)$$

[0110] It is as follows when matrix representation of a formula (14) and the formula (15) is carried out.

[0111]

[Equation 16]

$$\begin{bmatrix} 1 & \cos(\omega_0) & \cos(2\omega_0) & \cdots & \cos((R-1)\omega_0) & \frac{1}{\hat{W}(e^{j\omega_0})} \\ 1 & \cos(\omega_1) & \cos(2\omega_1) & \cdots & \cos((R-1)\omega_1) & \frac{-1}{\hat{W}(e^{j\omega_1})} \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 1 & \cos(\omega_{R-1}) & \cos(2\omega_{R-1}) & \cdots & \cos((R-1)\omega_{R-1}) & \frac{(-1)^{R-1}}{\hat{W}(e^{j\omega_{R-1}})} \\ 1 & \cos(\omega_R) & \cos(2\omega_R) & \cdots & \cos((R-1)\omega_R) & \frac{(-1)^R}{\hat{W}(e^{j\omega_R})} \\ 1 & \cos(\omega_{R+1}) & \cos(2\omega_{R+1}) & \cdots & \cos((R-1)\omega_{R+1}) & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 1 & \cos(\omega_{R+N_p}) & \cos(2\omega_{R+N_p}) & \cdots & \cos((R-1)\omega_{R+N_p}) & 0 \end{bmatrix} \begin{bmatrix} p(0) \\ p(1) \\ \vdots \\ p(R-1) \\ \delta \end{bmatrix}$$

$$= \begin{bmatrix} \hat{D}(e^{j\omega_0}) \\ \hat{D}(e^{j\omega_1}) \\ \vdots \\ \hat{D}(e^{j\omega_{R-1}}) \\ \hat{D}(e^{j\omega_R}) \\ \hat{D}(e^{j\omega_{R+1}}) \\ \vdots \\ \hat{D}(e^{j\omega_{R+N_p}}) \end{bmatrix} \qquad (16)$$

[0112] However, since solving this formula has dramatically much computational

complexity, it asks for delta analytically first.
[0113]
[Equation 17]

$$\delta = \frac{\sum_{j=0}^{R} \alpha_j \hat{D}(e^{j\omega_j})}{\sum_{j=0}^{R} (-1)^j \alpha_j / \hat{W}(e^{j\omega_j})} \qquad (17)$$

[0114]
[Equation 18]

$$\alpha_k = \prod_{\substack{j=0 \\ j \neq k}}^{R} \frac{1}{(x_k - x_j)} \qquad (18)$$

[0115]
[Equation 19]

$$x_j = \cos(\omega_j) \qquad (19)$$

[0116] alphak It is the complementary function of the element of the k line (R+1) train of Matrix F. However, a formula (8) and a formula (9) are used for ^W (ejw) and ^D (ejw), respectively. Next, it sets like a degree type using this delta.
[0117]
[Equation 20]

$$C_k = \hat{D}(e^{j\omega_k}) - (-1)^k \frac{\delta}{\hat{W}(e^{j\omega_k})} \qquad (20)$$

$$(k=0,\ldots,R)$$

[0118]
[Equation 21]

$$C_k = \hat{D}(e^{j\omega_k}), \quad (k=R+1,\ldots,R+N_p) \qquad (21)$$

[0119] In order to search for the amplitude characteristic of frequencies other than an extreme point, the Lagrange interpolation polynomial will be used this time as an interpolation polynomial interpolated using an extreme point and the frequency point which you want to pass. Namely, the Lagrange interpolation polynomial is used for P (ejw), and it is wk (k= 0, .., R+Np). Value Ck It is calculated by carrying out interpolation which is taken.
[0120]
[Equation 22]

$$P(e^{j\omega}) = \frac{\sum_{k=0}^{R+Np} C_k \left(\frac{\beta_k}{x - x_k} \right)}{\sum_{k=0}^{R+Np} \left(\frac{\beta_k}{x - x_k} \right)} \qquad (22)$$

[0121]
[Equation 23]

$$\beta_k = \prod_{\substack{j=0 \\ j \neq k}}^{R+Np} \frac{1}{(x_k - x_j)} \qquad (23)$$

[0122]
[Equation 24]

$$x = \cos(\omega) \qquad (24)$$

[0123] This result is equivalent to having solved the formula (16).
[0124] It judges [be / it / the no by which asking for a new extreme point, and (F103) and optimal approximation were acquired from the amplitude characteristic searched for from step2 interpolation polynomial] (F104). Each extreme point wk as a result of the above-mentioned step1 It does not necessarily become the extremal value of the error function E with weight (ejw), but is |E(ejw) |>delta (i). The becoming point may exist. Then, new extreme point w (i+1) It determines from the all-points simultaneous changing method.
The all-points simultaneous changing method: Ask the whole approximation band for the extremal value of the approximation error with weight calculated from the extreme point used for interpolation the search for a rear spring supporter based on a degree type, and it is new extreme point w (i+1) =wk (i+1) about it (k= 0, 1, .., R). It carries out and returns to processing of step1.
[0125]
[Equation 25]

$$E(e^{j\omega}) = \hat{W}(e^{j\omega})\left\{\hat{D}(e^{j\omega}) - P(e^{j\omega})\right\} \qquad (25)$$

[0126] When the location of extremal value will not change, suppose that optimal approximation was acquired. This is the terminating condition of a repeat and it progresses to the following processing of step3.
[0127] Drawing 8 is the conceptual diagram of the all-points changing method. When it explains briefly, the extreme point which the black dot in drawing 8 used for interpolation is expressed, and the approximation error E with weight (ejw) searched for from this extreme point is equivalent to a continuous line. Although the value of the approximation error with weight in the extreme point of a black dot serves as a white round head as shown in drawing 8 (A), actual extremal value is a square and shown frequency. Then, it is square and returns to processing of step1 by making the shown frequency into a new extreme point. Moreover, since the frequency of the extreme point used for interpolation and actual extremal value has shifted as shown in drawing 8 (B), it returns to processing of step1 by making the square and shown frequency into a new extreme point. And the extreme point used for interpolation as shown in drawing 8 (C) and the extreme point of a actual approximation error with

weight (white round head) Similarly a repeat is ended at the time of ****.

[0128] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step3 (F105). It asks from a degree type instead of asking from p (n), in case it asks for impulse response [of N tap] h (n) from the optimal-approximation function P (ejw).

[0129]

[Equation 26]

$$H(e^{j\omega})=P(e^{j\omega})\cdot Q(e^{j\omega})\cdot Z(e^{j\omega}) \qquad (26)$$

[0130]

[Equation 27]

場合1:

$$h(n)=\frac{1}{N}\left\{H(0)+2\sum_{k=1}^{\frac{N-1}{2}}(-1)^k H\left(\frac{2\pi}{N}k\right)\cos\left(\frac{2\pi}{N}k(n+\tfrac{1}{2})\right)\right\} \qquad (27)$$

[0131]

[Equation 28]

場合2:

$$h(n)=\frac{2}{N}\sum_{k=0}^{\frac{N}{2}-1}(-1)^k H\left(\frac{2\pi}{N}(k+\tfrac{1}{2})\right)\sin\left(\frac{2\pi}{N}(k+\tfrac{1}{2})(n+\tfrac{1}{2})\right) \qquad (28)$$

[0132]

[Equation 29]

場合3:

$$h(n)=-\frac{2}{N}\sum_{k=0}^{\frac{N-1}{2}}(-1)^k H\left(\frac{2\pi}{N}k\right)\sin\left(\frac{2\pi}{N}k(n+\tfrac{1}{2})\right) \qquad (29)$$

[0133]

[Equation 30]

場合4:

$$h(n)=\frac{2}{N}\sum_{k=0}^{\frac{N}{2}-1}(-1)^k H\left(\frac{2\pi}{N}(k+\tfrac{1}{2})\right)\cos\left(\frac{2\pi}{N}(k+\tfrac{1}{2})(n+\tfrac{1}{2})\right) \qquad (30)$$

[0134] Moreover, when asking for impulse response [of the equalizer of a L=N−(U−1) tap] k (n), it calculates from a degree type.

[0135]

[Equation 31]

$$K(e^{j\omega})=P(e^{j\omega})\cdot Q(e^{j\omega}) \qquad (31)$$

[0136]

[Equation 32]

場合1:

$$k(n)=\frac{1}{L}\left\{K(0)+2\sum_{k=1}^{\frac{L-1}{2}}(-1)^{k}K\left(\frac{2\pi}{L}k\right)\cos\left(\frac{2\pi}{L}k(n+\frac{1}{2})\right)\right\} \quad (32)$$

[0137]
[Equation 33]
場合2:

$$k(n)=\frac{2}{L}\sum_{k=0}^{\frac{L}{2}-1}(-1)^{k}K\left(\frac{2\pi}{L}(k+\frac{1}{2})\right)\sin\left(\frac{2\pi}{L}(k+\frac{1}{2})(n+\frac{1}{2})\right) \quad (33)$$

[0138]
[Equation 34]
場合3:

$$k(n)=-\frac{2}{L}\sum_{k=0}^{\frac{L-1}{2}}(-1)^{k}K\left(\frac{2\pi}{L}k\right)\sin\left(\frac{2\pi}{L}k(n+\frac{1}{2})\right) \quad (34)$$

[0139]
[Equation 35]
場合4:

$$k(n)=\frac{2}{L}\sum_{k=0}^{\frac{L}{2}-1}(-1)^{k}K\left(\frac{2\pi}{L}(k+\frac{1}{2})\right)\cos\left(\frac{2\pi}{L}(k+\frac{1}{2})(n+\frac{1}{2})\right) \quad (35)$$

[0140] As a pre-filter shows by the degree type, when transfer function Z (z) is 1, it is the same as the REMUZU exchange algorithm which passes the frequency point of arbitration.
[0141]
[Equation 36]
Z(z) =1 -- (36)
[0142] Moreover, when there is no frequency point of the arbitration which a pre-filter wants to pass and it is Np=0, it is the same as the REMUZU exchange algorithm in consideration of the frequency response of a pre-filter.
[0143] Furthermore, when there is no frequency point of arbitration [arbitration / as shown in a degree type, transfer function Z (z) is / arbitration / 1, and] to make it pass and a pre-filter is Np=0, it is the same as the usual REMUZU exchange algorithm.
[0144]
[Equation 37]
Z(z) =1 -- (37)
[0145] Drawing 9 is drawing showing the frequency response of the low pass filter designed with the REMUZU exchange algorithm extended so that the frequency point of arbitration might be passed and the frequency response of a pre-filter could be taken into consideration to the following specifications. In addition, in subsequent explanation, the zero point for avoiding chessboard distortion will be treated as a pre-

filter. The frequency response of a pre-filter is expressed as follows.

[0146]

[Equation 38]

$$Z(e^{j\omega}) = (1+e^{-j\omega}+e^{-2j\omega}+\cdots+e^{-j\omega(U-1)})$$

$$= \begin{cases} 1+\sum_{m=0}^{(U-1)/2} 2\cos(m\omega), & U\text{:odd} \\ \sum_{m=0}^{U/2} 2\cos\{(m+1/2)\omega)\}, & U\text{:even} \end{cases} \qquad (38)$$

[0147] Below, a specification is shown.

[0148] As symmetrical with a phase FIR filter, 24 taps, and ** as a straight line, U= 3 (it adjusts so that direct-current gain may be set to U)

The REMUZU exchange algorithm which passed the frequency point of the design approach and arbitration, and took the frequency response of a pre-filter into consideration designed.

[0149]

[A table 1]

バンド

バンド	周波数範囲	利得	重み
1	$0 \leqq \omega \leqq 0.3\pi$	3	1
2	$0.5\pi \leqq \omega \leqq \pi$	0	1

[0150]

[A table 2]

指定周波数点

周波数	利得
$\omega = 0$	3

[0151] Drawing showing the frequency response displayed by the drawing 9 (A) decibel, drawing in which drawing 9 (B) shows a display SHITA frequency response with a value as it is, drawing where drawing 9 (C) expanded the gain 3 neighborhood, and drawing 9 (D) are drawings which expanded the gain 0 neighborhood. The inside of drawing 9 (A) - (D) and a dotted line are the frequency characteristics (Pre-filter) of a pre-filter, and the frequency characteristics (Equalizer) of an equalizer. The frequency characteristics (Proposed H (z)) from which it was shown and the real curve was obtained eventually, and a vertical continuous line are H (z) in order to avoid chessboard distortion. = the frequency (Zero Point) which must be set to 0, and the black dot show the break of a band.

[0152] The gain of a pass band is maintaining constant value from drawing 9 (A), and it can check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the frequency point specified from drawing 9 (C). Furthermore, it can check maintaining equiripple from drawing 9 (C) and (D).

[0153] That is, the low pass filter designed with the REMUZU exchange algorithm

extended so that the frequency point of arbitration might be passed and the frequency response of a pre-filter could be taken into consideration can acquire a good frequency response characteristic.

[0154] Next, the algorithm with which it is satisfied of the magnitude of attenuation of the specified inhibition zone as a modification is explained. This algorithm is the magnitude of attenuation (approximation error with weight) of the specified inhibition zone to the low pass filter whose number of bands is 2, or a high pass filter using the REMUZU exchange algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration. It is the algorithm to satisfy. In addition, in the following explanation, although described supposing a low pass filter, a "pass band" and a "inhibition zone" become reverse to apply to a high pass filter.

[0155] As an approach for satisfying the magnitude of attenuation of an inhibition zone, three kinds of approaches shown below exist. The 1st is the terminal point frequency wp of a pass band. Adjustable and starting point frequency ws of an inhibition zone They are immobilization and the approach which considers the number of taps as immobilization. The 2nd is the terminal point frequency wp of a pass band. Immobilization and starting point frequency ws of an inhibition zone It is the approach which considers adjustable and the number of taps as immobilization. The 3rd is the terminal point frequency wp of a pass band. Immobilization and starting point frequency ws of an inhibition zone They are immobilization and the approach which makes the number of taps adjustable.

[0156] the following and the 1st, 2nd, and 3rd approaches -- a drawing -- relation -- the price -- **** is explained later on.

[0157] The magnitude of attenuation dBs of the inhibition zone specified in the 1st approach **** and one-eyed approach Terminal point frequency wp of the largest pass band to satisfy It will ask. Drawing 10 is drawing showing the flow chart of the algorithm which asks for the filter with which are satisfied of the magnitude of attenuation of an inhibition zone. Drawing 11 is the algorithm which asks for a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone, and shows the parameter (variable) which becomes free, and the parameter (variable) fixed.

[0158] Here, it is as follows when the parameter which becomes free with this algorithm, the object, and the principles of an algorithm are enumerated.

* free parameter: Terminal point frequency wp of a pass band it is .

* Object: Terminal point frequency wp of the largest pass band with which are satisfied of the magnitude of attenuation of the specified inhibition zone The filter which it has is obtained.

* Principle: The starting point frequency of a pass band and the frequency of the ends of an inhibition zone are immobilization, and the terminal point frequency of a pass band is a free parameter. At the Chebyshev approximation by the REMUZU

exchange algorithm, it is the terminal point frequency wp of - pass band. Starting point frequency ws of an inhibition zone The magnitude of attenuation of -> inhibition zone keeping away becomes large.
- Terminal point frequency wp of a pass band Starting point frequency ws of an inhibition zone The magnitude of attenuation of -> inhibition zone which approaches becomes small.
namely, starting point frequency ws of an inhibition zone from -- frequency w p (pre) near [a far frequency (w= 0 neighborhood)] the starting point frequency of w p (cur) -- and an inhibition zone Location wp of the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation which prepared as an initial frequency and was specified using the split half method It asks. In addition, although the most efficient approach is the dividing-into the golden section method in the linear search method of such a parameter, an understanding of an algorithm has adopted the easy split half method here.
[0159] The content of each step processings F102, F103, F104, and F105 of the algorithm explained to drawing 10 and the following is the same as the REMUZU exchange algorithm which was associated and was explained to drawing 7 and which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration. Therefore, the same sign as drawing 7 is used about these processings.
[0160] As shown in step10 drawing 10 , initial setting is performed first (F201). In this initial setting, at least a straight line sets up setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the initial frequency of a split half method. The item set up concretely is as follows.
- The number of taps, as symmetrical [a phase FIR filter] with ** as - straight line or a ** symmetrical, The number of bands - Two pieces, the starting point frequency of - pass band, the gain of - pass band, the frequency of the ends of - inhibition zone, - The gain of an inhibition zone, weighting to - pass band and an inhibition zone, the frequency and amplitude value of a point to make it pass, [amplitude value] - The multiplier of a pre-filter, and the magnitude of attenuation dBs (that is, the magnitude delta 2 of the ripple of an inhibition zone is pointed out) of - inhibition zone
Frequency w which becomes extremal value in - approximation band (0) = wk (0) (k= 0, .., R)
However, right superscript (i) The count of a repeat is expressed.
[0161] Moreover, drawing 12 is drawing showing the initial frequency of the split half method in the algorithm which asks for a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone. As shown in drawing 12 , in this example, the following values are given as an initial frequency of a split half method.

[0162]
[Equation 39]
$\omega_p^{(pre)}[0]$ = 阻止域の始点周波数の近傍 (39)
$\omega_p^{(cur)}[0]$ = 通過域の始点周波数の近傍 (40)

[0163] wp [t] which is back A part shall express the number of cycles. Here, it is a frequency w p (pre). [0] The minimum magnitude of attenuation [in / the REMUZU exchange algorithm which received, and passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration is performed, and / an inhibition zone] dB (pre) [0] The following steps are explained asking.
[0164] The REMUZU exchange algorithm which passed the frequency point of step11 arbitration and took the frequency response of a pre-filter into consideration is performed (F102, F103, F104). Specifically by processing F102, it is w p (cur). [t] Generation is generated for the interpolation polynomial which interpolates the amplitude characteristic from the extreme point at the time, and the frequency point which you want to pass. Subsequently, in processing F103, a new extreme point is determined from the amplitude characteristic searched for from the interpolation polynomial. And a repeat judgment of a REMUZU exchange algorithm is made in processing F104.
[0165] step12, next the magnitude of attenuation of an inhibition zone are investigated (F206). The minimum magnitude of attenuation [in / using the interpolation polynomial for which it asked by processing F102 / an inhibition zone] dB s (the greatest approximation error delta 2 with weight) (cur) [t] It investigates.
[0166] The comparison with step13, next the magnitude of attenuation of the specified inhibition zone is performed (F207). Specifically, it is the magnitude of attenuation dBs of the specified inhibition zone. When it compares and the following type (41) or the formula (42) is satisfied, it shifts to processing of step15 (F105). When not satisfied, it shifts to processing of step14 (F208).
[0167]
[Equation 40]
$$|dB_s^{(cur)}[t]-dB_s|<\varepsilon_1 \quad (41)$$

[0168]
[Equation 41]
$$|\omega_p^{(cur)}[t]-\omega_p^{(pre)}[t]|<\varepsilon_2 \quad (42)$$

[0169] However, epsilon 1 epsilon 2 The very small value is carried out.
[0170] The magnitude of attenuation dBs of the inhibition zone specified step14 In a comparison, when the above-mentioned formula (41) or the formula (42) is not satisfied, setting out of a band is changed (F208). Specifically, it is the terminal point frequency w p (cur) of a new pass band. [t+1] It sets up. The case of the first loop

formation, and in the case of the loop formation after a two-times eye, it divides as the setting-up method, and explains.

[0171] In the first time : the first case, three cases shown in drawing 13 can be considered. Namely, frequency w p (pre) [0] w p (cur) [0] It receives and the case shown in drawing 13 (A), (B), and (C) can be considered. The case shown in drawing 13 (A) is a case where the magnitude of attenuation which specified both is satisfied. In this case, starting point frequency ws of an inhibition zone Near frequency w p (pre) [0] It considers as a solution and progresses to processing of step15. The case shown in drawing 13 (B) is a case where the magnitude of attenuation which specified both is not satisfied. In this case, in the present number of taps, since the specified magnitude of attenuation is unrealizable, that is displayed and it ends. The case shown in drawing 13 (C) is a case where the magnitude of attenuation only specified by one of the two is satisfied. In this case, it carries out like the following type (43), and shifts to processing of step11. In addition, with how to give this initial frequency point, it is w p (pre). [0] It is satisfied and is w p (cur). [0] The case which is not satisfied does not exist.

[0172]

[Equation 42]

$$
\begin{aligned}
\omega_p^{(pre)}[1] &= \omega_p^{(cur)}[0] \\
\omega_p^{(cur)}[1] &= 0.5 \times (\omega_p^{(cur)}[0] + \omega_p^{(pre)}[0]) \\
dB^{(pre)}[1] &= dB^{(cur)}[0] \qquad (43)
\end{aligned}
$$

[0173] A two-times eye or subsequent ones: In after a two-times eye, two cases shown in drawing 14 can be considered. It sets to how to decide the new frequency after a two-times eye, and is w p (pre). The magnitude of attenuation dBs surely specified as [t+1] The frequency to satisfy is saved. Frequency w p (pre) [t] w p (cur) [t] It receives and the case shown in drawing 14 (A) and (B) can be considered. The case shown in drawing 14 (A) is a case where the magnitude of attenuation only specified by one of the two is satisfied. In this case, it carries out like the following type (44), and shifts to the following processing of step11. In addition, it is always w p (pre). [t] Since the frequency with which were satisfied of the specified magnitude of attenuation comes, it is wp (pre). [t] The case which is not satisfied does not exist.

[0174]

[Equation 43]

$$
\begin{aligned}
\omega_p^{(pre)}[t+1] &= \omega_p^{(pre)}[t] \\
\omega_p^{(cur)}[t+1] &= 0.5 \times (\omega_p^{(cur)}[t] + \omega_p^{(pre)}[t]) \qquad (44) \\
dB^{(pre)}[t+1] &= dB^{(pre)}[t]
\end{aligned}
$$

[0175] The case shown in drawing 14 (B) is a case where the magnitude of attenuation which specified both is satisfied. In this case, it carries out like the following type (45), and shifts to the following processing of step11.

[0176]

[Equation 44]

$$\omega_p^{(pre)}[t+1] = \omega_p^{(cur)}[t]$$

$$\omega_p^{(cur)}[t+1] = \omega_p^{(cur)}[t] + 0.5 \times (\omega_p^{(cur)}[t] + \omega_p^{(pre)}[t]) \qquad (45)$$

$$dB^{(pre)}[t+1] = dB^{(cur)}[t]$$

[0177] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step15 (F105). That is, at least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic acquired eventually.

[0178] Drawing 15 is drawing showing the frequency response characteristic of the low pass filter obtained by the algorithm which asks for "a filter with the terminal point frequency of the greatest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone" by making into a pre-filter the filter of the zero point which avoids chessboard distortion. Drawing showing the frequency response which displayed drawing 15 (A) by the decibel, drawing showing the frequency response which displayed drawing 15 (B) with the value as it is, drawing where drawing 15 (C) expanded the gain 3 neighborhood, and drawing 15 (D) are drawings which expanded the gain 0 neighborhood.

[0179] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.

[0180] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of arbitration and took the frequency characteristics of a pre-filter into consideration.

- terminal point frequency wp of a variable:pass band to ask for -40dB or less of magnitude of attenuation of 24 taps, ** symmetrical, U=3 (U double a filter factor so that direct-current gain may be set to U), and an inhibition zone it is .

[0181]

[A table 3]

バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leq \omega \leq \omega_p$	3	1
阻止域	$0.5\pi \leq \omega \leq \pi$	0	1

[0182]

[A table 4]

指定周波数点

周波数	利得
$\omega = 0$	3

[0183] In addition, the continuous line shows the frequency response of a low pass filter with the terminal point frequency of the greatest pass band with which are

satisfied of the magnitude of attenuation of an inhibition zone in drawing 15 . Moreover, in order that a vertical continuous line may avoid chessboard distortion, the frequency which must be set to H(z) =0 is shown, a dotted line shows the break of the band given beforehand, a vertical dotted line shows the break of a band, and the black dot shows the specified frequency point.

[0184] From drawing 15 (A), the magnitude of attenuation of the specified inhibition zone is realized, and the gain of a pass band is maintaining constant value, and it can check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the frequency point specified from drawing 15 (C). Furthermore, it can check maintaining equiripple from drawing 15 (C) and (D).

[0185] That is, the low pass filter obtained by the algorithm which asks for "the filter with the terminal point frequency of the greatest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone" concerning this invention has the good frequency response characteristic so that drawing 15 may show.

[0186] The magnitude of attenuation dBs of the inhibition zone specified in the 2nd approach, next 2nd approach Starting point frequency ws of the smallest inhibition zone to satisfy It will ask. A flow chart for that will become equivalent to drawing 10 referred to in the 1st approach. Drawing 16 is the algorithm which asks for a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone, and shows the parameter (variable) which becomes free, and the parameter (variable) fixed.

[0187] Here, it is as follows when the parameter which becomes free with this algorithm, the object, and the principles of an algorithm are enumerated.

* free parameter: Starting point frequency ws of an inhibition zone it is .
* Object: Starting point frequency ws of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of the specified inhibition zone The filter which it has is obtained.
* Principle: The frequency of the ends of a pass band and the terminal point frequency of an inhibition zone are immobilization, and the starting point frequency of an inhibition zone is a free parameter. the Chebyshev approximation by the REMUZU exchange algorithm - starting point frequency ws of this inhibition zone Terminal point frequency wp of a pass band The magnitude of attenuation of -> inhibition zone keeping away becomes large.

- starting point frequency ws of this inhibition zone Terminal point frequency wp of a pass band The magnitude of attenuation of -> inhibition zone which approaches becomes small.

Namely, frequency w s (pre) far from the terminal point frequency of a pass band Frequency w s (cur) near the terminal point frequency of a pass band Location ws of the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation which prepared as an initial frequency and was specified using the split half method It asks. In addition, also in this case, although the most

efficient approach is the dividing-into the golden section method in the linear search method of such a parameter, an understanding of an algorithm has adopted the easy split half method here.

[0188] Moreover, the content of each step processings F102, F103, F104, and F105 of the algorithm explained to drawing 10 and the following is the same as the REMUZU exchange algorithm which was associated and was explained to drawing 7 and which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration like the case of the 1st approach. Therefore, the same sign as drawing 7 is used about processing here.

[0189] As shown in step20 drawing 10 , initial setting is performed first (F201). In this initial setting, at least a straight line sets up setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the initial frequency of a split half method. The item set up concretely is as follows.

- The number of taps, as symmetrical [a phase FIR filter] with ** as - straight line or a ** symmetrical, The number of bands - The frequency of the ends of two pieces and - pass band, the gain of - pass band, the terminal point frequency of - inhibition zone, - The gain of an inhibition zone, weighting to - pass band and an inhibition zone, the frequency and amplitude value of a point to make it pass, [amplitude value] - The multiplier of a pre-filter, and the magnitude of attenuation dBs (that is, the magnitude delta 2 of the ripple of an inhibition zone is pointed out) of - inhibition zone Frequency w which becomes extremal value in - approximation band (0) = wk (0) (k= 0, .., R)

However, right superscript (i) The count of a repeat is expressed.

[0190] Moreover, drawing 17 is drawing showing the initial frequency of the split half method in the algorithm which asks for a filter with the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone. As shown in drawing 17 , in this example, the following values are given as an initial frequency of a split half method.

[0191]

[Equation 45]

$$\omega_s^{(pre)}[0] = \text{通過域の終点周波数の近傍} \quad (46)$$

$$\omega_s^{(cur)}[0] = \text{阻止域の終点周波数の近傍} \quad (47)$$

[0192] ws [t] which is back A part shall express the number of cycles. Here, it is a frequency w s (pre). [0] The minimum magnitude of attenuation [in / the REMUZU exchange algorithm which received, and passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration is performed, and / an inhibition zone] dB (pre) [0] The following steps are explained asking.

[0193] The REMUZU exchange algorithm which passed the frequency point of step21

arbitration and took the frequency response of a pre-filter into consideration is performed (F102, F103, F104). Specifically by processing F102, it is w s (cur). [t] Generation is generated for the interpolation polynomial which interpolates the amplitude characteristic from the extreme point at the time, and the frequency point which you want to pass. Subsequently, in processing F103, a new extreme point is determined from the amplitude characteristic searched for from the interpolation polynomial. And a repeat judgment of a REMUZU exchange algorithm is made in processing F104.

[0194] step22, next the magnitude of attenuation of an inhibition zone are investigated (F206). The minimum magnitude of attenuation [in / using the interpolation polynomial for which it asked by processing F102 / an inhibition zone] dB s (the greatest approximation error delta 2 with weight) (cur) [t] It investigates.

[0195] The comparison with step23, next the magnitude of attenuation of the specified inhibition zone is performed (F207). Specifically, it is the magnitude of attenuation dBs of the specified inhibition zone. When it compares and the following type (48) or the formula (49) is satisfied, it shifts to processing of step25 (F105). When not satisfied, it shifts to processing of step24 (F208).

[0196]

[Equation 46]

$$|dB_s^{(cur)}[t] - dB_s| < \varepsilon_1 \qquad (48)$$

[0197]

[Equation 47]

$$|\omega_s^{(cur)}[t] - \omega_s^{(pre)}[t]| < \varepsilon_2 \qquad (49)$$

[0198] However, epsilon 1 epsilon 2 It considers as a very small value.

[0199] In the comparison with the magnitude of attenuation of the inhibition zone specified step24, when the above-mentioned formula (48) or the formula (49) is not satisfied, setting out of a band is changed (F208). Specifically, it is the starting point frequency w s (cur) of a new inhibition zone. [t+1] It sets up. The case of the first loop formation, and in the case of the loop formation after a two-times eye, it divides as the setting-up method, and explains.

[0200] In the first time : the first case, three cases shown in drawing 18 can be considered. Namely, frequency w s (pre) [0] w s (cur) [0] It receives and the case shown in drawing 18 (A), (B), and (C) can be considered. The case shown in drawing 18 (A) is a case where the magnitude of attenuation which specified both is satisfied. In this case, frequency w s (pre) near w= 0 [0] It considers as a solution and progresses to processing of step25. The case shown in drawing 18 (B) is a case where the magnitude of attenuation which specified both is not satisfied. In this case, in the present number of taps, since the specified magnitude of attenuation is unrealizable, that is displayed and it ends. The case shown in drawing 18 (C) is a case

where the magnitude of attenuation only specified by one of the two is satisfied. In this case, it carries out like the following type (50), and shifts to processing of step21. In addition, with how to give this initial frequency point, it is w s (pre). [0] It is satisfied and is w s (cur). [0] The case which is not satisfied does not exist.

[0201]

[Equation 48]

$$
\begin{aligned}
\omega_s^{(pre)}[1] &= \omega_s^{(cur)}[0] \\
\omega_s^{(cur)}[1] &= 0.5\times(\omega_s^{(cur)}[0]+\omega_s^{(pre)}[0]) \qquad (50) \\
dB_s^{(pre)}[1] &= dB_s^{(cur)}[0]
\end{aligned}
$$

[0202] A two-times eye or subsequent ones: In after a two-times eye, two cases shown in drawing 19 can be considered. how to decide the new frequency after a two-times eye -- setting -- w s (pre) [t+1] **** -- the surely specified magnitude of attenuation dBs The frequency to satisfy will be saved. Frequency w s (pre) [t] w s (cur) [t] It receives and the case shown in drawing 19 (A) and (B) can be considered. When [this] it is the case where the magnitude of attenuation only specified by one of the two is satisfied, the case shown in drawing 19 (A) is carried out like the following formula (51), and shifts to the following processing of step21. In addition, it is always w s (pre). [t] Since the frequency with which were satisfied of the magnitude of attenuation comes, it is w s (pre) [t]. The case which is not satisfied does not exist.

[0203]

[Equation 49]

$$
\begin{aligned}
\omega_s^{(pre)}[t+1] &= \omega_s^{(pre)}[t] \\
\omega_s^{(cur)}[t+1] &= 0.5\times(\omega_s^{(cur)}[t]+\omega_s^{(pre)}[t]) \qquad (51) \\
dB_s^{(pre)}[t+1] &= dB_s^{(pre)}[t]
\end{aligned}
$$

[0204] The case shown in drawing 19 (B) is a case where the magnitude of attenuation which specified both is satisfied. In this case, it carries out like the following type (52), and shifts to the following processing of step21.

[0205]

[Equation 50]

$$
\begin{aligned}
\omega_s^{(pre)}[t+1] &= \omega_s^{(cur)}[t] \\
\omega_s^{(cur)}[t+1] &= \omega_s^{(cur)}[t]+0.5\times(\omega_s^{(cur)}[t]-\omega_s^{(pre)}[t]) \qquad (52) \\
dB_s^{(pre)}[t+1] &= dB_s^{(cur)}[t]
\end{aligned}
$$

[0206] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step25 (F105). That is, at least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic acquired eventually.

[0207] Drawing 20 is drawing showing the frequency response characteristic of the low pass filter obtained by the algorithm which asks for "a filter with the starting point frequency of the minimum inhibition zone with which are satisfied of the magnitude of

attenuation of an inhibition zone" by making into a pre-filter the filter of the zero point which avoids chessboard distortion. Drawing showing the frequency response which displayed drawing 20 (A) by the decibel, drawing showing the frequency response which displayed drawing 20 (B) with the value as it is, drawing where drawing 20 (C) expanded the gain 3 neighborhood, and drawing 20 (D) are drawings which expanded the gain 0 neighborhood.

[0208] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.

[0209] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of arbitration and took the frequency characteristics of a pre-filter into consideration.

- starting point frequency ws of a variable:inhibition zone to ask for -40dB or less of magnitude of attenuation of 24 taps, ** symmetrical, U=3 (U double a filter factor so that direct-current gain may be set to U), and an inhibition zone it is .

[0210]

[A table 5]

バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leqq \omega \leqq 0.3\pi$	3	1
阻止域	$\omega_S \leqq \omega \leqq \pi$	0	1

[0211]

[A table 6]

指定周波数点

周波数	利得
$\omega = 0$	3

[0212] In addition, it sets in drawing 20 and the continuous line shows the frequency response of a low pass filter with the starting point frequency of the minimum inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone. Moreover, in order that a vertical continuous line may avoid chessboard distortion, the frequency which must be set to H(z) =0 is shown, a dotted line shows the break of the band given beforehand, a vertical dotted line shows the break of a band, and the black dot shows the specified frequency point.

[0213] From drawing 20 (A), the magnitude of attenuation of the specified inhibition zone is realized, and the gain of a pass band is maintaining constant value, and it can check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the specified frequency point from drawing 20 (C). Furthermore, it can check maintaining equiripple from drawing 20 (C) and (D).

[0214] That is, the low pass filter obtained by the algorithm which asks for "the filter with the starting point frequency of the minimum inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" concerning this

invention has the good frequency response characteristic so that drawing 20 may show.

[0215] The magnitude of attenuation dBs of the inhibition zone specified as the 3rd approach last in the 3rd approach It will ask for the minimum number N of taps to satisfy. Drawing 21 is drawing showing the flow chart of the algorithm which asks for the filter of the minimum number of taps with which are satisfied of the magnitude of attenuation of an inhibition zone.

[0216] Here, it is as follows when the parameter which becomes free, the object, and the principles of an algorithm are enumerated with this algorithm.

* Free parameter: It is the number of taps.

* Object: The filter of the number of the minimum taps with which are satisfied of the magnitude of attenuation of the specified inhibition zone is obtained.

* Principle: All the variables of a band are an increase of one tap, and ** about the number of taps, when the magnitude of attenuation of the specified inhibition zone cannot be satisfied, since it is immobilization.

[0217] Moreover, the content of each step processings F102, F103, and F104 of the algorithm explained to drawing 21 and the following and F105** is the same as the REMUZU exchange algorithm which was associated and was explained to drawing 7 and which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration like the case of the 1st approach. Moreover, the content of processing F206 is the same as that of the processing which was associated and was explained to drawing 10 like the case of the 2nd approach. Therefore, about processing here, the same sign as drawing 7 and drawing 10 is used.

[0218] As shown in step30 drawing 21 , initial setting is performed first (F401). In this initial setting, at least a straight line performs setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, input of the frequency point of arbitration [arbitration] to make it pass, and setting out of an initial extreme point. The item set up concretely is as follows.

At least the number of initial taps, and - straight line - A phase FIR filter The number of symmetrical with ** or a ** symmetrical, and - bands Two pieces, the starting point frequency and terminal point frequency of - each band, - The gain of each band, weighting of - each band, the frequency and amplitude value of a point to make it pass, [amplitude value] - The multiplier of a pre-filter, and the magnitude of attenuation dBs (that is, the magnitude delta 2 of the ripple of an inhibition zone is pointed out) of - inhibition zone Frequency w which becomes extremal value in - approximation band (0) = wk (0) (k= 0, .., R)

However, right superscript (i) The count of a repeat is expressed.

[0219] The REMUZU exchange algorithm which passed the frequency point of step31 arbitration and took the frequency response of a pre-filter into consideration is performed (F102, F103, F104). Specifically by processing F102, it is w p (cur). Generation is generated for the interpolation polynomial which interpolates the

amplitude characteristic from the extreme point at the time of [t], and the frequency point which you want to pass. Subsequently, in processing F103, a new extreme point is determined from the amplitude characteristic searched for from the interpolation polynomial. And a repeat judgment of a REMUZU exchange algorithm is made in processing F104.
[0220] step32, next the magnitude of attenuation of an inhibition zone are investigated (F206). The minimum magnitude of attenuation [in / using the interpolation polynomial for which it asked by processing F102 / an inhibition zone] dB s (the greatest approximation error delta 2 with weight) (cur) [t] It investigates.
[0221] The comparison with step33, next the magnitude of attenuation of the specified inhibition zone is performed (F412). Specifically, it is the magnitude of attenuation dBs of the specified inhibition zone. When it compares and the following type (53) is satisfied, it shifts to processing of step35 (F105). When not satisfied, it shifts to processing of step34 (F413).
[0222]
[Equation 51]

$$dB_s^{(cur)}[t] < dB_s \qquad (53)$$

[0223] The increase of step341 tap, and ** (F413). That is, the current number of taps is shifted to 1 tap increase coconut and processing of step30.
[0224] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step35 (F105). That is, at least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic acquired eventually.
[0225] Drawing 22 is drawing showing the frequency response characteristic of the low pass filter obtained by the algorithm which asks for "the minimum number of taps which realizes the magnitude of attenuation of an inhibition zone" by making into a pre-filter the filter of the zero point which avoids chessboard distortion. Drawing showing the frequency response which displayed drawing 22 (A) by the decibel, drawing showing the frequency response which displayed drawing 22 (B) with the value as it is, drawing where drawing 22 (C) expanded the gain 3 neighborhood, and drawing 22 (D) are drawings which expanded the gain 0 neighborhood.
[0226] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.
[0227] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of arbitration and took the frequency characteristics of a pre-filter into consideration.
- an initial tap -- several variable:taps to ask for -60dB or less of magnitude of attenuation of number 10 tap, ** symmetrical, U-3 (U double a filter factor so that direct-current gain may be set to U), and an inhibition zone -- it is N.
[0228]

[A table 7]
バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leqq \omega \leqq 0.3\pi$	3	1
阻止域	$0.5\pi \leqq \omega \leqq \pi$	0	1

[0229]
[A table 8]
指定周波数点

周波数	利得
$\omega = 0$	3

[0230] In addition, the continuous line shows the frequency response of the low pass filter of the minimum number of taps (35 taps) from which the magnitude of attenuation of an inhibition zone is set to −60dB or less in drawing 22 . Moreover, a vertical dotted line shows the frequency used as the zero point for avoiding chessboard distortion, a dotted line shows the break of the band given beforehand, a vertical dotted line shows the break of a band, and the black dot shows the specified frequency point.
[0231] From drawing 22 (A), the magnitude of attenuation of the specified inhibition zone is realized, and the gain of a pass band is maintaining constant value, and it can check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the specified frequency point from drawing 22 (C). Furthermore, it can check maintaining equiripple from drawing 22 (C) and (D).
[0232] That is, the low pass filter obtained by the algorithm which asks for the "number of taps of the min which realizes the magnitude of attenuation of an inhibition zone" concerning this invention has the good frequency response characteristic so that drawing 22 may show.
[0233] Next, as the 2nd modification, the magnitude of attenuation of an inhibition zone is satisfied and the algorithm which asks for the filter which passes the frequency point of a transient region is explained.
[0234] Here, it is as follows when the parameter which becomes free with this algorithm, the object, and the principles of an algorithm are enumerated.
* free parameter: Terminal point frequency wp of a pass band Starting point frequency ws of an inhibition zone it is .
* Object: The magnitude of attenuation dBs of an inhibition zone It is satisfied and is the frequency wc of a transient region. Magnitude of attenuation dBc The band to pass is determined. Namely, specific frequency wc of a transient region Magnitude of attenuation dBc Terminal point frequency wp of largest pass band that becomes Starting point frequency ws of the smallest inhibition zone It obtains.
* Principle: The starting point frequency of a pass band and the terminal point frequency of an inhibition zone are immobilization, and it is the terminal point

frequency wp of a pass band. Starting point frequency ws of an inhibition zone It is a free parameter. Since there are two free parameters, it cannot be decided appropriately that it moves simultaneously. Then, parameter of one of the two is fixed and it asks for another [which satisfies the magnitude of attenuation of an inhibition zone] parameter. Frequency wc of a transient region Magnitude of attenuation dBc The parameter which was being fixed is changed when not passing. By repeating repeatedly [above], it is the magnitude of attenuation dBc at the frequency wc of a transient region. The band to pass is determined. Since "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" has in two kinds of approaches, i.e., the 1st, and the approach of asking for the parameter with which are satisfied of the magnitude of attenuation of an inhibition zone has "a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone" in the 2nd, order is explained for the algorithm which used each as the base later on.

[0235] Drawing 23 is drawing showing the flow chart of the algorithm which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region. First, it relates with drawing 23 – drawing 28 , and the algorithm which used "the filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" as the base is explained.

[0236] That is, with this algorithm, the algorithm which asks for "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" is used. The policy of a concrete algorithm is ws considering the above-mentioned algorithm as an inside loop formation, as shown in drawing 24 . It asks and is wp to an outside further. The loop formation for asking is put and the parameter of a band is determined. That is, it is the terminal point frequency wp of a pass band at an outside loop formation. It fixes and is the magnitude of attenuation dBs of an inhibition zone at an inside loop formation. Starting point frequency ws of the inhibition zone to satisfy It asks. the time of looking for "a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone", when having not passed the point (wc and dBc) of the transient region specified by the amplitude characteristic searched for -- the same -- wp It searches using a split half method. Although a concrete algorithm is shown below, since the algorithm which asks for "the filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" which is an inside loop formation is the same, explanation is omitted.

[0237] Moreover, the content of each step processings F102, F103, and F104 of the algorithm explained to drawing 23 and the following and F105** is the same as the REMUZU exchange algorithm which was associated and was explained to drawing 7

and which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration like the case of the 1st approach. Moreover, the content of processings F206, F207, and F208 is the same as that of the algorithm of the processing which was associated and was explained to drawing 10 , i.e., "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone", like the case of the 2nd approach. Therefore, about processing here, the same sign as drawing 7 and drawing 10 is used.
[0238] step40 -- first, as shown in drawing 23 , initial setting is performed (F301). In this initial setting, at least a straight line sets up setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the initial frequency of a split half method. The item set up concretely is as follows. - The number of taps, as symmetrical [a phase FIR filter] with ** as - straight line or a ** symmetrical, The number of bands - Two pieces, the starting point frequency w= 0 of - pass band, the gain of - pass band, - The gain of terminal point frequency w=pi of an inhibition zone, and - inhibition zone, weighting to - pass band and an inhibition zone, - The frequency of the point which you want to pass, the multiplier of amplitude value and - pre-filter, the magnitude of attenuation dBs () of - inhibition zone namely, magnitude delta 2 of the ripple of an inhibition zone it points out -- frequency wc of - transient region Frequency w (0) which becomes extremal value in the magnitude of attenuation dBc and - approximation band =wk (0) (k= 0, ..., R) However, right superscript (i) The count of a repeat is expressed.
[0239] Moreover, drawing 25 is drawing showing the initial frequency of the split half method in the algorithm which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region. As shown in drawing 25 , in this example, it considered as the initial frequency of a split half method, and the following values are given.
[0240]
[Equation 52]

$$\omega_p^{(pre)}[0] = \text{通過域の始点周波数の近傍} \qquad (54)$$

$$\omega_p^{(cur)}[0] = \omega_c\text{の近傍} \qquad (55)$$

[0241] wp [t] which is back A part shall express the number of cycles. Here, it is a frequency w p (pre). [0] It receives. The specified magnitude of attenuation [in / the REMUZU exchange algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration is performed, and / an inhibition zone] dBs Starting point frequency w s (pre) of the minimum inhibition zone to satisfy [0] is calculated. wc at that time Gain dB c which can be set (cur) [0] The following steps are explained being obtained.

[0242] The algorithm which calculates step41 ″a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone″ is performed (F102, F103, F104, F206, F207, F208). Specifically by processing F102, it is w p (cur). [t] The interpolation polynomial which interpolates the amplitude characteristic from the extreme point at the time and the frequency point which you want to pass is generated. Subsequently, in processing F103, a new extreme point is determined from the amplitude characteristic searched for from the interpolation polynomial. And a repeat judgment of a REMUZU exchange algorithm is made in processing F104. Next, in processing F206, the minimum magnitude of attenuation (the greatest approximation error with weight) in an inhibition zone is calculated. Next, starting point frequency ws of the smallest inhibition zone with which it is satisfied of the magnitude of attenuation of an inhibition zone in processing F207 The terminating condition of the algorithm which asks for the filter which it has is acquired. Moreover, it sets to processing F208 and is the starting point frequency w s (cur) of a new inhibition zone. It sets up.
[0243] The magnitude of attenuation of the frequency specified as step42, next a transient region is investigated (F309). Frequency wc specified as the transient region in processing F102 using the Lagrange interpolation polynomial which was able to be found eventually with the algorithm which asks for ″the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone″ The receiving magnitude of attenuation dB c (cur) [t] It investigates.
[0244] The comparison with the assignment magnitude of attenuation of step43 transient region is performed (F310). Frequency wc of a transient region The receiving magnitude of attenuation dBc When it compares and the following type (56) or the formula (57) is satisfied, it shifts to processing of step45 (F105), and when not satisfied, it shifts to processing of step44 (F311).
[0245]
[Equation 53]

$$|dB_c^{(cur)}[t]-dB_c| < \varepsilon_1 \qquad (56)$$

[0246]
[Equation 54]

$$|\omega_p^{(cur)}[t]-\omega_p^{(pre)}[t]| < \varepsilon_2 \qquad (57)$$

[0247] However, epsilon 1 epsilon 2 The very small value is carried out.
 [0248] Frequency wc of step44 transient region The receiving magnitude of attenuation dBc In a comparison, when the above-mentioned formula (56) or the formula (57) is not satisfied, setting out of a band is changed (F311). Specifically, it is the terminal point frequency w p (cur) of a new pass band. [t+1] It sets up. The case of the first loop formation, and in the case of the loop formation after a two-times eye, it divides as

the setting-up method, and explains.
[0249] In the first time : the first case, three cases shown in drawing 26 can be considered. Namely, frequency w p (pre) [0] w p (cur) [0] It receives and the case shown in drawing 26 (A), (B), and (C) can be considered. The case shown in drawing 26 (A) is the magnitude of attenuation dBc which specified both. It is the satisfied case. In this case, large frequency w p (cur) [0] It considers as a solution and progresses to processing of step45. The case shown in drawing 26 (B) is a case where the magnitude of attenuation which specified both is not satisfied. In this case, in the present number of taps, since the specified magnitude of attenuation is unrealizable, that is displayed and it ends. The case shown in drawing 26 (C) is a case where the magnitude of attenuation only specified by one of the two is satisfied. In this case, it carries out like the following type (58), and shifts to processing of step41. In addition, with how to give this initial frequency, it is w p (cur). [0] It is satisfied and is w p (pre) [0]. The case which is not satisfied does not exist.
[0250]
[Equation 55]

$$\omega_p^{(pre)}[1] = \omega_p^{(pre)}[0]$$
$$\omega_p^{(cur)}[1] = 0.5 \times (\omega_p^{(cur)}[0] + \omega_p^{(pre)}[0]) \qquad (58)$$
$$dB_c^{(pre)}[1] = dB_c^{(pre)}[0]$$

[0251] A two-times eye or subsequent ones: In after a two-times eye, two cases shown in drawing 27 can be considered. new frequency w p (cur) after a two-times eye [t+1] how to determine -- setting -- w p (pre) [t+1] **** -- surely -- the assignment magnitude of attenuation dBc The frequency to satisfy is saved. Frequency w p (pre) [t] w p (cur) [t] The case which it receives and is shown in drawing 27 (A) and (B) can be considered. The case shown in drawing 27 (A) is a case where the magnitude of attenuation only specified by one of the two is satisfied. In this case, it is made like and shifts to the following processing of step41 at the following formula (59). In addition, it is always w p (pre). [t] Since the frequency with which were satisfied of the specified magnitude of attenuation comes, it is wp (pre). [t] The case which is not satisfied does not exist.
[0252]
[Equation 56]

$$\omega_p^{(pre)}[t+1] = \omega_p^{(pre)}[t]$$
$$\omega_p^{(cur)}[t+1] = 0.5 \times (\omega_p^{(cur)}[t] + \omega_p^{(pre)}[t]) \qquad (59)$$
$$dB_c^{(pre)}[t+1] = dB_c^{(pre)}[t]$$

[0253] The case shown in drawing 27 (B) is a case where the magnitude of attenuation which specified both is satisfied. In this case, it is made like and shifts to the following processing of step41 at the following formula (60).
[0254]

[Equation 57]

$$\omega_p^{(pre)}[t+1] = \omega_p^{(cur)}[t]$$
$$\omega_p^{(cur)}[t+1] = \omega_p^{(cur)}[t] + 0.5 \times (\omega_p^{(cur)}[t] - \omega_p^{(pre)}[t]) \qquad (60)$$
$$dB_c^{(pre)}[t+1] = dB_c^{(cur)}[t]$$

[0255] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step45 (F105). That is, at least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic acquired eventually.

[0256] Drawing 28 is drawing showing the frequency response characteristic of the low pass filter obtained by the algorithm which asks for "the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region" which used as the base the algorithm which asks for "a filter with the starting point frequency of the minimum inhibition zone" by making into a pre-filter the filter of the zero point which avoids chessboard distortion. Drawing showing the frequency response which displayed drawing 28 (A) by the decibel, drawing showing the frequency response which displayed drawing 28 (B) with the value as it is, drawing where drawing 28 (C) expanded the gain 3 neighborhood, and drawing 28 (D) are drawings which expanded the gain 0 neighborhood.

[0257] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.

[0258] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of arbitration of asking for the starting point frequency of the minimum inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone, and took the frequency response of a pre-filter into consideration.

- They are 0.4pi and 12dB Symmetrical with passage, 24 taps, and **, and U= 3 (U double a filter factor so that direct-current gain may be set to U)
- terminal point frequency wp of a variable:pass band to ask for -40dB or less of magnitude of attenuation of an inhibition zone Starting point frequency ws of an inhibition zone it is .

[0259]

[A table 9]

バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leq \omega \leq \omega_p$	3	1
阻止域	$\omega_s \leq \omega \leq \pi$	0	1

[0260]

[A table 10]

指定周波数点

周波数	利得
$\omega = 0$	3

[0261] In addition, in drawing 28 , a continuous line satisfies the magnitude of attenuation of an inhibition zone, and shows the frequency response of the low pass filter which passes the frequency point of a transient region. Moreover, a black dot shows the specified frequency point (the frequency point of a transient region, and frequency point of arbitration), and the vertical continuous line shows the frequency which must be set to H(z) =0, in order to avoid chessboard distortion.

[0262] From drawing 28 (A), the magnitude of attenuation of the specified inhibition zone is realized, and the gain of a pass band is maintaining constant value, and it can check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the frequency point specified as the transient region from drawing 28 (B). Moreover, it can check having passed the specified frequency point from drawing 28 (C). Furthermore, it can check maintaining equiripple from drawing 28 (C) and (D).

[0263] That is, the low pass filter obtained by the algorithm which asks for "the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region" which used as the base the algorithm which asks for "a filter with the starting point frequency of the minimum inhibition zone" has the good frequency response characteristic so that drawing 28 may show.

[0264] Next, it relates and the algorithm which used as the base the algorithm which asks for a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone is explained to drawing 23 , drawing 29 – drawing 33 . The flow chart in this case satisfies the magnitude of attenuation of an inhibition zone, and will become equivalent to drawing 23 referred to in the algorithm which asks for the filter which passes the frequency point of a transient region.

[0265] With this algorithm, the algorithm which asks for "a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone" is used. The policy of a concrete algorithm is wp considering the above-mentioned algorithm as an inside loop formation, as shown in drawing 29 . It asks and is ws to an outside further. The loop formation for asking is put and the parameter of a band is determined. That is, it is the starting point frequency ws of an inhibition zone at an outside loop formation. It fixes and is the assignment magnitude of attenuation dBs of an inhibition zone at an inside loop formation. Terminal point frequency wp of the pass band to satisfy It asks. the time of looking for "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone", when having not passed the point (wc and dBc) of the transient region specified by the amplitude characteristic searched for -- the same -- ws It searches using a split half method. Although an algorithm is shown below concretely, since the algorithm which asks for "the filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone" which is an

inside loop formation is the same, explanation is omitted.

[0266] Moreover, the content of each step processings F102, F103, and F104 of the algorithm explained to drawing 23 and the following and F105** is the same as the REMUZU exchange algorithm which was associated and was explained to drawing 7 and which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration like the case of the 1st approach. Moreover, the content of processings F206, F207, and F208 is the same as that of the algorithm of the processing which was associated and was explained to drawing 10 , i.e., "a filter with the terminal point frequency of the largest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone", like the case of the 2nd approach. Therefore, about processing here, the same sign as drawing 7 and drawing 10 is used.

[0267] As shown in step50 drawing 23 , initial setting is performed first (F301). In this initial setting, at least a straight line sets up setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, the input of the frequency point of arbitration [arbitration] to make it pass, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the initial frequency of a split half method. The item set up concretely is as follows.
- The number of taps, as symmetrical [a phase FIR filter] with ** as - straight line or a ** symmetrical, The number of bands - Two pieces, the starting point frequency w= 0 of - pass band, the gain of - pass band, - The gain of terminal point frequency w=pi of an inhibition zone, and - inhibition zone, weighting to - pass band and an inhibition zone, - The frequency of the point which you want to pass, the multiplier of amplitude value and - pre-filter, the magnitude of attenuation dBs () of - inhibition zone namely, magnitude delta 2 of the ripple of an inhibition zone it points out -- frequency wc of - transient region Frequency w (0) which becomes extremal value in the magnitude of attenuation dBc and - approximation band =wk (0) (k= 0, .., R) However, right superscript (i) The count of a repeat is expressed.

[0268] Moreover, drawing 30 is drawing showing the initial frequency of the split half method in the algorithm which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region. As shown in drawing 30 , in this example, the following values are given as an initial frequency of a split half method.

[0269]

[Equation 58]

$$\omega_s^{(cot)}[0] = \text{阻止域の終点周波数の近傍} \qquad (61)$$

[0270] another w s (pre) [0] ws which was able to be found with the algorithm which looks for "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" as a value as follows w s (pre) [0] ** -- it is carrying out.

[Equation 59]

$$\omega_p^{(pre)}[0] = \text{通過域の始点周波数の近傍} \quad (62)$$

[0271] In addition, wp which is [an inhibition zone] satisfied with this of the magnitude of attenuation although it should search as the following formula (63) properly speaking It is not found. Then, wp The minimum value is the starting point frequency ws of the inhibition zone with which it is satisfied of the magnitude of attenuation of the inhibition zone at this time since it is about 0.01. It is considering as the initial frequency.

[0272]

[Equation 60]

$$\omega_t^{(pre)}[0] = \omega_c\text{の近傍} \quad (63)$$

[0273] ws [t] which is back A part shall express the number of cycles. Here, it is a frequency w s (pre). [0] It receives. The specified magnitude of attenuation [in / the REMUZU exchange algorithm which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration is performed, and / an inhibition zone] dBs Terminal point frequency w p (pre) of the greatest pass band to satisfy [0] is calculated. wc at that time Gain dB c which can be set (pre) [0] The following steps are explained being obtained.

[0274] The algorithm which calculates step51 "a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone" is performed (F102, F103, F104, F206, F207, F208). Specifically by processing F102, it is w s (cur). [t] The interpolation polynomial which interpolates the amplitude characteristic from the extreme point at the time and the frequency point which you want to pass is generated. Subsequently, in processing F103, a new extreme point is determined from the amplitude characteristic searched for from the interpolation polynomial. And a repeat judgment of a REMUZU exchange algorithm is made in processing F104. Next, in processing F206, the minimum magnitude of attenuation (the greatest approximation error with weight) in an inhibition zone is calculated. Next, terminal point frequency wp of the smallest inhibition zone with which it is satisfied of the magnitude of attenuation of an inhibition zone in processing F207 The terminating condition of the algorithm which asks for the filter which it has is acquired. Moreover, it sets to processing F208 and is the starting point frequency w p (cur) of a new inhibition zone. It sets up.

[0275] The magnitude of attenuation of the frequency specified as step52, next a transient region is investigated (F309). Frequency wc specified as the transient region in processing F102 using the Lagrange interpolation polynomial which was able to be found eventually with the algorithm which asks for "the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone" The receiving magnitude of attenuation dB c (cur) It investigates.

[0276] The comparison with the magnitude of attenuation of the transient region specified step53 is performed (F310). Frequency wc of the specified transient region The receiving magnitude of attenuation dBc When it compares and the following type (64) or the formula (65) is satisfied, it shifts to processing of step55 (F105), and when not satisfied, it shifts to processing of step54 (F311).
[0277]
[Equation 61]

$$|dB_c^{(cur)}[t]-dB_c| < \varepsilon_1 \qquad (64)$$

[0278]
[Equation 62]

$$|\omega_p^{(cur)}[t]-\omega_p^{(pre)}[t]| < \varepsilon_2 \qquad (65)$$

[0279] However, it was referred to as epsilon1 =0.1dB and epsilon2 =10-4. **.
[0280] Frequency wc of step54 transient region The receiving magnitude of attenuation dBc In a comparison, when the above-mentioned formula (64) or the formula (65) is not satisfied, setting out of a band is changed (F311). Specifically, it is the terminal point frequency w s (cur) of a new pass band. [t+1] It sets up. The case of the first loop formation, and in the case of the loop formation after a two-times eye, it divides as the setting-up method, and explains.
[0281] In the first time : the first case, three cases shown in drawing 31 can be considered. Namely, frequency w s (pre) [0] w s (cur) [0] It receives and the case shown in drawing 31 (A), (B), and (C) can be considered. The case shown in drawing 31 (A) is the magnitude of attenuation dBc which specified both. It is the satisfied case. In this case, large frequency w s (cur) [0] It considers as a solution and progresses to processing of step55. The case shown in drawing 31 (B) is a case where the magnitude of attenuation which specified both is not satisfied. In this case, in the present number of taps, since the specified magnitude of attenuation is unrealizable, that is displayed and it ends. The case shown in drawing 31 (C) is a case where the magnitude of attenuation only specified by one of the two is satisfied. In this case, it carries out like the following type (66), and shifts to processing of step51. In addition, with how to give this initial frequency, it is w s (cur). [0] It is satisfied and is w s (pre) [0]. The case which is not satisfied does not exist.
[0282]
[Equation 63]

$$\begin{aligned} \omega_s^{(pre)}[1] &= \omega_s^{(pre)}[0] \\ \omega_s^{(cur)}[1] &= 0.5\times(\omega_s^{(cur)}[0]+\omega_s^{(pre)}[0]) \qquad (66) \\ dB_c^{(pre)}[1] &= dB_s^{(cur)}[0] \end{aligned}$$

[0283] A two-times eye or subsequent ones: In after a two-times eye, two cases shown in drawing 32 can be considered. new frequency w s (cur) after a two-times

eye [t+1] how to determine -- setting -- w s (pre) [t+1] **** -- surely -- the assignment magnitude of attenuation dBc The frequency to satisfy is saved. Frequency w s (pre) [t] w s (cur) [t] The case which it receives and is shown in drawing 32 (A) and (B) can be considered. The case shown in drawing 32 (A) is a case where the magnitude of attenuation only specified by one of the two is satisfied. In this case, it is made like and shifts to the following processing of step51 at the following formula (67). In addition, it is always w s (pre). [t] Since the frequency with which were satisfied of the specified magnitude of attenuation comes, it is ws (pre). [t] The case which is not satisfied does not exist.

[0284]

[Equation 64]

$$\begin{aligned} \omega_s^{(pre)}[t+1] &= \omega_s^{(pre)}[t] \\ \omega_s^{(cur)}[t+1] &= 0.5\times(\omega_s^{(cur)}[t]+\omega_s^{(pre)}[t]) \qquad (67) \\ dB_c^{(pre)}[t+1] &= dB_c^{(pre)}[t] \end{aligned}$$

[0285] The case shown in drawing 32 (B) is a case where the magnitude of attenuation which specified both is satisfied. In this case, it is made like and shifts to the following processing of step51 at the following formula (68).

[0286]

[Equation 65]

$$\begin{aligned} \omega_s^{(pre)}[t+1] &= \omega_s^{(cur)}[t] \\ \omega_p^{(cur)}[t+1] &= \omega_s^{(cur)}[t]+0.5\times(\omega_s^{(cur)}[t]-\omega_s^{(pre)}[t]) \qquad (68) \\ dB_c^{(pre)}[t+1] &= dB_c^{(cur)}[t] \end{aligned}$$

[0287] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step55 (F105). That is, at least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic acquired eventually.

[0288] Drawing 33 is drawing showing the frequency response characteristic of the low pass filter obtained by the algorithm which asks for "the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region" which used as the base the algorithm which asks for "it is a filter about the terminal point frequency of the greatest pass band." Drawing showing the frequency response which displayed drawing 33 (A) by the decibel, drawing showing the frequency response which displayed drawing 33 (B) with the value as it is, drawing where drawing 33 (C) expanded the gain 3 neighborhood, and drawing 33 (D) are drawings which expanded the gain 0 neighborhood.

[0289] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.

[0290] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of arbitration of asking for the terminal point frequency of the

greatest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone, and took the frequency response of a pre-filter into consideration.
- They are 0.4pi and 12dB Symmetrical with passage, 24 taps, and **, and U= 3 (U double a filter factor so that direct-current gain may be set to U)
- terminal point frequency wp of a variable:pass band to ask for -40dB or less of magnitude of attenuation of an inhibition zone Starting point frequency ws of an inhibition zone it is .

[0291]

[A table 11]

バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leqq \omega \leqq \omega_p$	3	1
阻止域	$\omega_s \leqq \omega \leqq \pi$	0	1

[0292]

[A table 12]

指定周波数点

周波数	利得
$\omega = 0$	3

[0293] In addition, in drawing 33 , a continuous line satisfies the magnitude of attenuation of an inhibition zone, and shows the frequency response of the low pass filter which passes the frequency point of a transient region. Moreover, a black dot shows the specified frequency point (the frequency point of a transient region, and frequency point of arbitration), and the vertical continuous line shows the frequency which must be set to H(z) =0, in order to avoid chessboard distortion.
[0294] From drawing 33 (A), the magnitude of attenuation of the specified inhibition zone is realized, and the gain of a pass band is maintaining constant value, and it can check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the frequency point specified as the transient region from drawing 33 (B). Moreover, it can check having passed the specified frequency point from drawing 33 (C). Furthermore, it can check maintaining equiripple from drawing 33 (C) and (D).
[0295] That is, the low pass filter obtained by the algorithm which asks for "the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region" which used as the base the algorithm which asks for "it is a filter about the terminal point frequency of the greatest pass band" has the good frequency response characteristic so that drawing 33 may show.
[0296] Next, the algorithm of the filter design of the number of the minimum taps with which are satisfied of the magnitude of attenuation of an inhibition zone is explained to the REMUZU exchange algorithm which can change a band. Here, the algorithm which asks for the filter of the number of the minimum taps which realizes the

magnitude of attenuation of the specified inhibition zone is explained to the algorithm which searches for the above "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone", and the algorithm which searches for the above "a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone."

[0297] Drawing 34 is drawing showing the flow chart of the algorithm which asks for the filter of the number of the minimum taps which realizes the magnitude of attenuation of an inhibition zone.

[0298] It is as follows when the parameter which becomes free with this algorithm, the object, and the principles of an algorithm are enumerated.

* Free parameter : the number of – taps and two kinds of approaches exist. Terminal point frequency wp of the 1st pass band It considers as adjustable and the starting point frequency ws of an inhibition zone is fixed. Terminal point frequency wp of the 2nd pass band It fixes and is the starting point frequency ws of an inhibition zone. It considers as adjustable.

* Object: The magnitude of attenuation dBs of the inhibition zone whose one of the variables of a band is adjustable and which was specified by carrying out an algorithm pair The filter of the number of the minimum taps to satisfy is obtained.

* principle: 1 since the magnitude of attenuation which the number of taps was lacking and was specified cannot be realized when becoming "having no solution" by the loop formation of eye a time -- 1 the increase of the number of taps -- it carries out and tries again.

[0299] Moreover, the content of each step processings F102, F103, and F104 of the algorithm explained to drawing 34 and the following and F105** is the same as the REMUZU exchange algorithm which was associated and was explained to drawing 7 and which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration like the case of the 1st approach. Moreover, the content of processings F201, F206, F207, and F208 is the same as that of the algorithm of the processing which was associated and was explained to drawing 10 , i.e., "a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone", and the algorithm of "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" like the case of the 2nd approach. Therefore, about processing here, the same sign as drawing 7 and drawing 10 is used.

[0300] As shown in step60 drawing 34 , initial setting is performed first (F201). In this initial setting, at least a straight line sets up an input, setting out of an initial extreme point, assignment of the magnitude of attenuation of an inhibition zone, and the initial frequency of a split half method for setting out of a phase FIR filter, setting out of a band, setting out of the multiplier of a pre-filter, and the frequency point of arbitration

[arbitration] to make it pass. The item set up concretely is as follows.
- The number of taps, as symmetrical [a phase FIR filter] with ** as - straight line or a ** symmetrical, The number of bands - Two pieces, the starting point frequency w= 0 of - pass band, the gain of - pass band, - The gain of terminal point frequency w=pi of an inhibition zone, and - inhibition zone, weighting to - pass band and an inhibition zone, - The multiplier of the frequency point of a point and amplitude value to make it pass, and - pre-filter, the magnitude of attenuation dBs () of - inhibition zone [amplitude value] namely, magnitude delta 2 of the ripple of an inhibition zone it points out -- frequency w (0) which becomes extremal value in - approximation band =wk (0) However (k= 0, .., R), right superscript (i) The count of a repeat is expressed.
- The input of the initial frequency of a split half method [0301] The REMUZU exchange algorithm which passed the frequency point of step61 arbitration and took the frequency response of a pre-filter into consideration is performed (F102, F103, F104). Specifically by processing F102, generation is generated for the interpolation polynomial which interpolates the amplitude characteristic from an extreme point and the frequency point which you want to pass. Subsequently, in processing F103, a new extreme point is determined from the amplitude characteristic searched for from the interpolation polynomial. And a repeat judgment of a REMUZU exchange algorithm is made in processing F104.
[0302] step62, next the minimum magnitude of attenuation in an inhibition zone (the greatest approximation error with weight) It asks (F206).
[0303] It distinguishes whether the terminating condition of the search algorithm of a frequency which satisfies the magnitude of attenuation of the inhibition zone specified step63 is realized (F207). When a terminating condition is realized, and it shifts to processing of step67 (F105) and is not realized, it shifts to processing of step64 (F208).
[0304] When the terminating condition of the search algorithm of a frequency which satisfies the magnitude of attenuation of the inhibition zone specified step64 is not realized, setting out of a band is changed (F208).
[0305] The comparison with the magnitude of attenuation of the inhibition zone specified step65 is performed (F414). In setting-out modification of the band of processing F208, when becoming "having no solution" by the 1st loop formation, it shifts to processing of step66 (F415), and when other, it returns to processing of step61.
[0306] The increase of step661 tap, and ** (F415). The current number of taps is shifted to 1 tap increase coconut and the initialization process of step60 (F201).
[0307] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step67 (F105).
[0308] Drawing 35 is drawing showing the frequency response characteristic of the low pass filter obtained by the algorithm which asks for "the minimum number of taps with which are satisfied of the magnitude of attenuation of an inhibition zone" by

making into a pre-filter the filter of the zero point which avoids chessboard distortion. Drawing showing the frequency response which displayed drawing 35 (A) by the decibel, drawing showing the frequency response which displayed drawing 35 (B) with the value as it is, drawing where drawing 35 (C) expanded the gain 3 neighborhood, and drawing 35 (D) are drawings which expanded the gain 0 neighborhood.

[0309] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.

[0310] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of arbitration of asking for a filter with the starting point frequency of the minimum inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone, and took the frequency characteristics of a pre-filter into consideration.

- The magnitude of attenuation of ** symmetrical, U=3 (U double a filter factor so that direct-current gain may be set to U), and an inhibition zone is the starting point frequency ws of a variable:, tap several N, and an inhibition zone to ask -60dB or less [0311].

[A table 13]

バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leqq \omega \leqq 0.3\pi$	3	1
阻止域	$\omega s \leqq \omega \leqq \pi$	0	1

[0312]

[A table 14]

指定周波数点

周波数	利得
$\omega = 0$	3

[0313] In addition, the continuous line shows the frequency response of the low pass filter of the minimum number of taps (17 taps) from which the magnitude of attenuation of an inhibition zone is set to -60dB or less in drawing 35 . Moreover, in order that a vertical continuous line may avoid chessboard distortion, the frequency which must be set to H (z) is shown, a dotted line shows the break of the band given beforehand, a vertical dotted line shows the break of a band, and the black dot shows the specified frequency point.

[0314] From drawing 35 (A), the magnitude of attenuation of the specified inhibition zone is realized, and the gain of a pass band is maintaining constant value, and it can check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the specified frequency point from drawing 35 (C). Furthermore, it can check maintaining equiripple from drawing 35 (C) and (D).

[0315] That is, the low pass filter obtained by the algorithm which asks for "the minimum number of taps with which are satisfied of the magnitude of attenuation of

an inhibition zone" has the good frequency response characteristic so that drawing 35 may show.

[0316] Moreover, drawing 36 is drawing showing the frequency response of the low pass filter obtained by the algorithm which asks for "the minimum number of taps which realizes the magnitude of attenuation of the specified inhibition zone" by making into a pre-filter the filter of the zero point which avoids chessboard distortion. Drawing showing the frequency response which displayed drawing 36 (A) by the decibel, drawing showing the frequency response which displayed drawing 36 (B) with the value as it is, drawing where drawing 36 (C) expanded the gain 3 neighborhood, and drawing 36 (D) are drawings which expanded the gain 0 neighborhood.

[0317] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.

[0318] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of arbitration of asking for a filter with the terminal point frequency of the greatest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone, and took the frequency characteristics of a pre-filter into consideration.

- The magnitude of attenuation of ** symmetrical, U=3 (U double a filter factor so that direct-current gain may be set to U), and an inhibition zone is the terminal point frequency wp of a variable:, tap several N, and an inhibition zone to ask -60dB or less [0319].

[A table 15]

バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leqq \omega \leqq \omega p$	3	1
阻止域	$0.5\pi \leqq \omega \leqq \pi$	0	1

[0320]

[A table 16]

指定周波数点

周波数	利得
$\omega = 0$	3

[0321] In addition, the continuous line shows the frequency response of the low pass filter of the minimum number of taps (21 taps) from which the magnitude of attenuation of an inhibition zone is set to -60dB or less in drawing 36 . Moreover, in order that a vertical continuous line may avoid chessboard distortion, the frequency which must be set to H (z) is shown, a dotted line shows the break of the band given beforehand, a vertical dotted line shows the break of a band, and the black dot shows the specified frequency point.

[0322] From drawing 36 (A), the magnitude of attenuation of the specified inhibition zone is realized, and the gain of a pass band is maintaining constant value, and it can

check having passed through the zero point which avoids chessboard distortion. Moreover, it can check having passed the specified frequency point from drawing 36 (C). Furthermore, it can check maintaining equiripple from drawing 36 (C) and (D).
[0323] That is, the low pass filter obtained by the algorithm which asks for "the minimum number of taps which realizes the magnitude of attenuation of the specified inhibition zone" has the good frequency response characteristic so that drawing 36 may show.
[0324] Next, the magnitude of attenuation of an inhibition zone is satisfied and the algorithm which asks for the filter of the number of the minimum taps which passes frequency **** of a transient region is explained. Here, the algorithm which asks for the filter of the number of the minimum taps which satisfies the magnitude of attenuation of an inhibition zone, and passes the frequency point of a transient region is explained to the algorithm which searches for the above "the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region."
[0325] Drawing 37 is drawing showing the flow chart of the algorithm which asks for the filter of the number of the minimum taps which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[0326] It is as follows when the parameter which becomes free with this algorithm, the object, and the principles of an algorithm are enumerated.
* Free parameter : starting point frequency ws* object of the terminal point frequency wp and the inhibition zone of the number of -- taps, and a pass band: The magnitude of attenuation dBs of the specified inhibition zone It is satisfied and is the frequency wc of a transient region. Magnitude of attenuation dBc The filter of the number of the minimum taps to pass is obtained. Namely, specific frequency wc of a transient region Magnitude of attenuation dBc Terminal point frequency wp of largest pass band that becomes Starting point frequency ws of the smallest inhibition zone It decides and the filter used as the minimum number of taps is obtained.
* principle: since the magnitude of attenuation which the number of taps was lacking and was specified cannot be realized when becoming "having no solution" by the 1st loop formation -- the increase of the number of 1 taps -- it carries out and tries again. Moreover, when the frequency point of a transient region is unrealizable, the number of 1 taps is increased and it tries again.
[0327] Moreover, the content of each step processings F102, F103, and F104 of the algorithm explained to drawing 37 and the following and F105** is the same as the REMUZU exchange algorithm which was associated and was explained to drawing 7 and which passed the frequency point of arbitration and took the frequency response of a pre-filter into consideration like the case of the 1st approach. Moreover, the content of processings F206, F207, and F208 is the same as that of the algorithm of the processing which was associated and was explained to drawing 10 , i.e., "a filter with the terminal point frequency of the largest pass band with which are satisfied of

the magnitude of attenuation of an inhibition zone", or the algorithm of "a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone" like the case of the 2nd approach. Furthermore, the content of processings F301, F309, F310, and F311 is the same as that of the processing which was associated and was explained to drawing 23 , i.e., "the algorithm which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the assignment magnitude of attenuation in the specific frequency of a transient region." Therefore, about processing here, drawing 7 , drawing 10 , and the same sign as drawing 23 are used.

[0328] As shown in step70 drawing 37 , initial setting is performed first (F301). Initial setting of the algorithm which asks for the filter which passes the magnitude of attenuation which satisfied the magnitude of attenuation of an inhibition zone, and was specifically specified as the transient region is performed. The item set up concretely is as follows.

At least the number of initial taps, and - straight line - A phase FIR filter The number of symmetrical with ** or a ** symmetrical, and - bands Two pieces, the starting point frequency w= 0 of - pass band, the gain of - pass band, - The gain of terminal point frequency w=pi of an inhibition zone, and - inhibition zone, weighting to - pass band and an inhibition zone, - The frequency of the point which you want to pass, the multiplier of amplitude value and - pre-filter, the magnitude of attenuation dBs () of - inhibition zone namely, magnitude delta 2 of the ripple of an inhibition zone it points out -- frequency wc of - transient region Frequency w (0) which becomes extremal value in the magnitude of attenuation dBc and - approximation band =wk (0) However (k= 0, .., R), right superscript (i) The count of a repeat is expressed.

- The input of the initial frequency of a split half method [0329] The REMUZU exchange algorithm which passed the frequency point of step71 arbitration and took the frequency response of a pre-filter into consideration is performed (F102, F103, F104). Specifically by processing F102, generation is generated for the interpolation polynomial which interpolates the amplitude characteristic from an extreme point and the frequency point which you want to pass. Subsequently, in processing F103, a new extreme point is determined from the amplitude characteristic searched for from the interpolation polynomial. And a repeat judgment of a REMUZU exchange algorithm is made in processing F104.

[0330] step72, next the minimum magnitude of attenuation in an inhibition zone (the greatest approximation error with weight) It asks (F206).

[0331] It distinguishes whether the terminating condition of the search algorithm of a frequency which satisfies the magnitude of attenuation of the inhibition zone specified step73 is realized (F207). When a terminating condition is realized, and it shifts to processing of step77 (F309) and is not realized, it shifts to processing of step74 (F208).

[0332] When the terminating condition of the search algorithm of a frequency which

satisfies the magnitude of attenuation of the inhibition zone specified step74 is not realized, setting out of a band is changed (F208).

[0333] The comparison with the magnitude of attenuation of the inhibition zone specified step75 is performed (F414). In setting-out modification of the band of processing F208, when becoming "having no solution" by the 1st loop formation, it shifts to processing of step76 (F415), and when other, it returns to processing of step71.

[0334] The increase of step761 tap, and ** (F415). The current number of taps is shifted to 1 tap increase coconut and the initialization process of step70 (F301).

[0335] The magnitude of attenuation of the frequency which the terminating condition of the search algorithm of a frequency which satisfies the magnitude of attenuation of the inhibition zone specified step77 changed, and was specified as the ****** case in the transient region is investigated (F309).

[0336] The comparison with the magnitude of attenuation of the inhibition zone specified step78 is performed (F310). When a terminating condition is realized, and it shifts to processing of step82 (F105) and is not realized, it shifts to processing of step79 (F311).

[0337] When step79 terminating condition is not realized, setting out of a band is changed (F311).

[0338] The comparison with the magnitude of attenuation of the inhibition zone specified step80 is performed (F416). In setting-out modification of the band of processing F311, when becoming "having no solution" by the 1st loop formation, it shifts to processing of step81 (F417), and when other, it returns to processing of step71.

[0339] The increase of step811 tap, and ** (F417). The current number of taps is shifted to 1 tap increase coconut and the initialization process of step70 (F301).

[0340] At least a straight line asks for the multiplier of a phase FIR filter from the amplitude characteristic approximated step82 (F105).

[0341] Drawing 38 is drawing showing the frequency response characteristic of the low pass filter obtained by the algorithm which asks for "the filter of the minimum number of taps which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region." Drawing showing the frequency response which displayed drawing 38 (A) by the decibel, drawing showing the frequency response which displayed drawing 38 (B) with the value as it is, drawing where drawing 38 (C) expanded the gain 3 neighborhood, and drawing 38 (D) are drawings which expanded the gain 0 neighborhood.

[0342] The basic algorithm, the variable to ask, band, and assignment frequency point in this case are as follows.

[0343] Basic algorithm: It is the REMUZU exchange algorithm which passed the frequency point of the arbitration which obtains the filter which passes the frequency point of a transient region which used as the base the algorithm which asks for the

terminal point frequency of the greatest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone, and took the frequency response of a pre-filter into consideration.
- It is the starting point frequency ws [0344] of the terminal point frequency wp and the inhibition zone of the variable:, tap several N, and the pass band which the magnitude of attenuation of passage, ** symmetrical, U=3 (U double a filter factor so that direct-current gain may be set to U), and an inhibition zone wants to ask for 0.4pi and 12dB -60dB or less.
[A table 17]
バンド

バンド	周波数範囲	利得	重み
通過域	$0 \leqq \omega \leqq \omega_p$	3	1
阻止域	$\omega_s \leqq \omega \leqq \pi$	0	1

[0345]
[A table 18]
指定周波数点

周波数	利得
$\omega = 0$	3
$\omega = 2\pi/3$	0

[0346] In addition, the continuous line shows the frequency response of the low pass filter of the minimum number of taps (17 taps) from which the magnitude of attenuation of an inhibition zone is -60dB or less, and turns into -12dB or less of magnitude of attenuation by frequency 0.4pi of a transient region in drawing 38 . Moreover, a dotted line shows the break of the band decided beforehand, and the black dot shows the frequency point of the specified transient region.
[0347] It can check having realized the magnitude of attenuation of the specified inhibition zone from drawing 38 (A). It can check that ** has passed the frequency point specified as the transient region from drawing 38 (B). Moreover, it can check having passed the specified frequency point from drawing 38 (C) and (D).
[0348] That is, the low pass filter obtained by the algorithm which asks for "the filter of the minimum number of taps which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region" has the good frequency response characteristic so that drawing 38 may show.
[0349]
[Effect of the Invention] As explained above, according to this invention, there is an advantage which ripples [error / with weight / approximation] do not collapse and can be held to stability. Moreover, there is an advantage which can hold the gain of a pass band to constant value. Moreover, the specified frequency point can be passed.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the transversal mold circuitry of an FIR filter.
[Drawing 2] It is the frequency response of a filter and the enlarged drawing of the gain 3 neighborhood which were designed in consideration of the frequency response of the pre-filter in the conventional approach.
[Drawing 3] It is the frequency response of a filter and the enlarged drawing of the gain 3 neighborhood which specified the frequency point of the arbitration in the conventional approach, and were designed.
[Drawing 4] An FIR filter is drawing in which at least a straight line shows the impulse response with a phase in four.
[Drawing 5] At least a straight line is drawing showing Q (ejw) and R to four cases of a phase FIR filter.
[Drawing 6] It is drawing showing the example of Chebyshev approximation with weight.
[Drawing 7] It is the flow chart of the REMUZU exchange algorithm in consideration of the frequency response of the pre-filter concerning this invention.
[Drawing 8] It is drawing for explaining the method of determining the new extremal value of the approximation error E with weight (ejw).
[Drawing 9] It is drawing showing the frequency response and enlarged drawing when specifying the frequency point of the arbitration of this invention.
[Drawing 10] It is drawing showing the flow chart of the algorithm which asks for the filter with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 11] It is drawing showing the parameter of the algorithm which asks for a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 12] It is drawing showing the initial frequency of the split half method in the algorithm which asks for a filter with the terminal point frequency of the largest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 13] It is drawing having shown modification of band setting out in the first loop formation.
[Drawing 14] It is drawing showing modification of band setting out in the loop formation after a two-times eye.
[Drawing 15] It is drawing showing the frequency response and enlarged drawing of a filter with the terminal point frequency of the greatest pass band with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 16] It is drawing showing the parameter of the algorithm which asks for a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone.

[Drawing 17] It is drawing showing the initial frequency of the split half method in the algorithm which asks for a filter with the starting point frequency of the smallest inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 18] It is drawing showing modification of band setting out in the first loop formation.
[Drawing 19] It is drawing showing modification of band setting out in the loop formation after a two-times eye.
[Drawing 20] It is drawing showing the frequency response and enlarged drawing of a filter with the starting point frequency of the minimum inhibition zone with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 21] It is drawing showing the flow chart of the algorithm which asks for the filter of the minimum number of taps with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 22] It is drawing showing the frequency response and enlarged drawing of the filter of the minimum number of taps which realizes the magnitude of attenuation of an inhibition zone.
[Drawing 23] It is drawing showing the flow chart of the algorithm which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 24] It is drawing showing the algorithm (1) which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 25] It is drawing showing the initial frequency of the split half method in the algorithm which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 26] It is drawing showing modification of band setting out in the first loop formation.
[Drawing 27] It is drawing showing modification of band setting out in the loop formation after a two-times eye.
[Drawing 28] It is drawing showing the frequency response and enlarged drawing of the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 29] It is drawing showing the algorithm (2) which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 30] It is drawing showing the initial frequency of the split half method in the algorithm which asks for the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 31] It is drawing showing modification of band setting out in the first loop formation.

[Drawing 32] It is drawing showing modification of band setting out in the loop formation after a two-times eye.
[Drawing 33] It is drawing showing the frequency response and enlarged drawing of the filter which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 34] It is drawing showing the flow chart of the algorithm which asks for the filter of the minimum number of taps which realizes the magnitude of attenuation of an inhibition zone.
[Drawing 35] It is drawing showing the frequency response and enlarged drawing of the filter of the minimum number of taps with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 36] It is drawing showing the frequency response and enlarged drawing of the filter of the minimum number of taps with which are satisfied of the magnitude of attenuation of an inhibition zone.
[Drawing 37] It is drawing showing the flow chart of the algorithm which asks for the filter of the minimum number of taps which satisfies the magnitude of attenuation of an inhibition zone and passes the frequency point of a transient region.
[Drawing 38] It is drawing showing the frequency response and enlarged drawing of the filter of the number of the minimum taps which satisfies the magnitude of attenuation of an inhibition zone, and passes the frequency point of a transition region.
[Description of Notations]
1 -- At least a straight line is a phase FIR filter and 2-1 to 2-n-1. -- [-- An adder, h (0) - h (n-1) / -- A filter factor, TIN / -- An input terminal and TOUT / -- output terminal.] A delay machine, 3-1 - 3-n -- A multiplier, 4